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CHEMICAL SECTION.

Section of Photography and Microscopy.

Joint Meeting, held Thursday, February 18, 1904.

Results of an Investigation of the Durability of Paints for the Protection of Structural Work.

BY ROBERT JOB,

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A former standard practice for a period of about ten years upon the Philadelphia and Reading Railway for painting bridges consisted in the use of three paints, officially known as No. 8, No. 10, and No. 12, respectively. No. 8 was a red body color, No. 10 a brown, and No. 12 a green trimming color. The composition of the three was essentially the same and consisted of about 22 per cent. sesquioxide of iron, with the remainder partly argillaceous gangue and partly hydrated sulphate of lime, each being ground in pure raw linseed oil, and diluted for use with raw linseed oil and our standard japan.

Notwithstanding the similarity of composition, very marked differences were noted in the relative durability in service. No. 8, under ordinary conditions, gave fair protection to steel for about three years, while No. 12, side by side with No. 8 upon the same structure and under identically the same conditions, had at least double the life of the latter. The life of No. 10 paint was intermediate between the others.

Fig. 1 is typical of the condition of our bridges four years after application of these paints. The horizontal railing

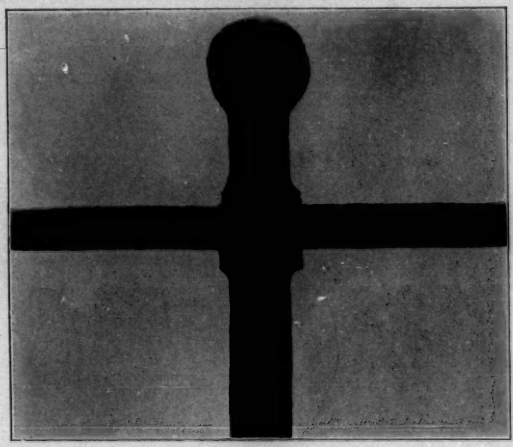

FIG. 1.—Bridge hand-rail and post, showing difference in protective value of two different standard paints after four years' exposure.

was covered with No. 8 paint, and was so badly corroded after four years' service that the paint could easily be detached. The vertical post had been coated at the same time with No. 12 paint, and the entire surface was in good condition after the four years, without a rust spot, and the metal beneath the paint was clean and bright. *Fig. 2* represents a post on the same bridge coated with No. 8 paint,

and it is seen that the metal is badly pitted and covered with rust.

The steel coated with No. 8 paint was very generally pitted and in bad condition, while that painted with No. 12 was well protected and practically free from rust, with clean metal beneath the paint.

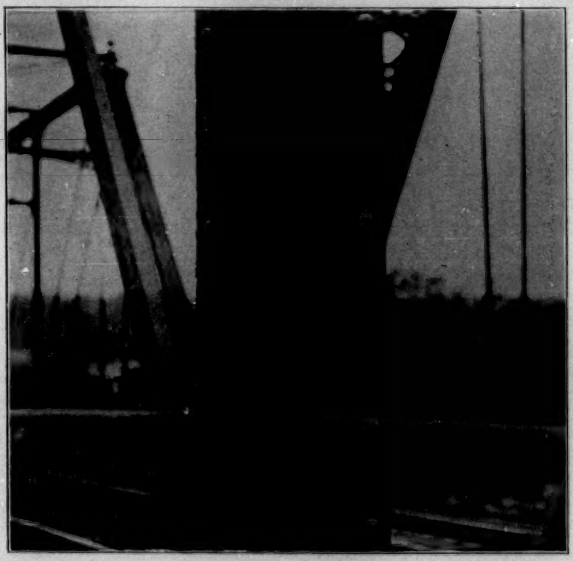

FIG. 2.—Bridge column, painted same as railing, Fig. 1. Badly pitted.

No. 10 paint averaged better than No. 8, but was considerably inferior to No. 12.

Having found that the above general results attended the use of these paints over our lines, we began an investigation to determine the causes of the variations, and to work out specifications which would ensure durability at least equal to that of No. 12 paint.

Upon analysis we found the following composition:

	No. 8. Per cent.	No. 10. Per cent.	No. 12. Per cent.
Silica	9·35	17·07	34·10
Alumina	4·44	5·06	19·56
Sesquioxide of iron	21·07	22·74	23·24
Sulphate of lime, hydrated	64·70	52·21	10·66
Alkalies	·44 (by diff.)	2·92 (by diff.)	·49
Water combined with iron and clay,			9·75
Prussian blue			2 10
Carbon black			·32
Free sulphuric acid	None.	None.	None.
Calcium carbonate	None.	None.	None.
	100·00	100·00	100·22
Total water combined			11 88

In a general way each pigment may be said to be composed of about 22 per cent. of sesquioxide of iron and 78 per cent. of inert filler, and the composition shown gives little indication of the cause of the variation in relative durability since practically the same proportion of sesquioxide of iron is present in each, and the fillers used are inert.

We next turned to the physical condition of the pigment, and upon microscopic examination found marked differences.

In No. 8 the largest particles had a diameter of ·0180 inch, there were relatively many of diameter of ·0100 inch, and the diameter of the finest was about ·0002 inch.

In No. 10 the largest particles were about the same size as in No. 8, but there were many fine particles of a diameter of about ·0002 inch, and the average was considerably smaller than that of No. 8, but greater than that of No. 12.

In No. 12 pigment the largest diameter was about ·0010 inch, with very few of that size, and that of the smallest particles was about ·0002 inch, and the whole layer was uniform and exceedingly fine.

As nearly as we could estimate it, the average diameter of No. 8 pigment was about ·0080 inch, while that of No. 12 was about ·0004 inch, considering each particle roughly as a sphere. Volumes of spheres are to one another as the cubes of their diameters, and it follows that the average volume of

a particle of No. 8 pigment was about 8,000 times greater than that of the average No. 12 particle.

The next point to be determined was the effect which the above differences in relative size would have upon the coating in service, and in order to render any differences readily visible, we diluted the paste of each paint with definite proportions of raw linseed oil and standard japan, using our regular batch formula for service work. We then painted vertical glass surfaces with each, and let dry at the ordinary temperature. We then viewed each under the microscope, throwing the light through the glass in such manner as to permit distinguishing each individual particle of the pigment, and again found marked characteristic differences.

In No. 8 paint relatively large oil spaces were present around the particles of pigment.

In No. 10 there was but little such clear space, and in the No. 12 paint the particles were practically touching one another, and were generally piled in several layers deep, thus breaking up the continuity of the oil-film effectively.

Considering the difference previously found in relative size of the three pigments, it appeared evident that the presence of the clear oil-spaces in the case of No. 8 paint were due to the fact that the particles of pigment in that paint were so large that they could not be supported by the oil-film, and therefore gradually dragged down and separated.

In the weathering of linseed-oil paints the oil is gradually acted upon, and the rapidity and extent of such action increases with decreased proportion of pigment in the mixture, as proven by the well-known experiments of Dudley and Pease,* the reason evidently being that as the relative size of oil-films between individual particles of pigment diminishes, the chance for the penetration of water and other rust promoters through the oil to the metal is correspondingly decreased.

From the standpoint of efficiency, it is evidently imma-

* *The Railroad and Engineering Journal*, 1890, page 417.

terial whether relatively large oil-spaces around particles of pigment are due to small proportion of pigment as compared with that of oil, or whether they are due to relative large size of the particles. The result is the same in either case, and a fairly solid and unbroken surface of pigment is not obtainable, as shown above, when the paint is spread in service, and, as a consequence, the elements necessary to cause rusting find comparatively easy access to the metal beneath such coating.

Fineness of subdivision of pigment is of well-recognized importance, and in the many valuable discussions in recent years such condition has been frequently stated to be essential to the best results,* and such expressions coincide with practical experience everywhere. Consequently, the striking variations found in the physical condition of the above pigments gave ample reason for the relative differences in service value.

Up to this point our investigation had shown the nature of the differences in the three pigments. The next step was to find some means by which these differences could readily be seen in practice, and shipments held to the standard of the No. 12 paint.

The ordinary fineness test as formerly made, diluting 5 parts by weight of the paste with 4 parts by weight of raw linseed oil, mixing thoroughly, and placing a few drops of the paint upon a clean dry glass, standing vertical at a temperature of 70° F. for twenty minutes, and specifying that no separation of pigment from oil should result, was found inadequate, for all three paints easily passed such test. We therefore began to increase the severity of the conditions in order to reach the point when the No. 12 paint would just pass the test. After experiment we fixed upon a temperature of 100° F., instead of 70° F., as better adapted to our object, and diluted the paste, which contained approximately 26 per cent. of oil, in proportions of 4 parts by weight of paste to 10 parts by weight of pure raw linseed oil. When diluted in this manner and thoroughly mixed, a few drops

* "Iron Corrosion." Louis E. Andés, page 127, and others.

of the paint were placed upon a clean dry glass and stood vertical at a temperature of 100° F. for one hour. Under this test No. 12 paint showed no signs of separation of pigment from oil, and but slight fading of color on comparing the coating at top and bottom, respectively, of the glass, after the test. Under these same conditions No. 8 paint separated badly and the color at top faded out almost completely; in other words, the greater part of the pigment dragged down, leaving little more than clear oil above. No. 10 paint was intermediate between the others and showed

FIG. 3.—Fineness test of three standard paints. One-half actual size.

some separation and fading, though in much less degree than in the case of No. 8 paint. In *Fig. 3* the fineness test of the three is represented, each containing exactly the same proportions of oil and pigment, and all being placed upon a single slip of glass side by side under the conditions given above.

The photograph was taken upon an illuminated white background, and consequently the larger the proportion of pigment remaining upon the glass after the test, the more complete the shutting out of the light, and the darker the

appearance. No. 12 is upon the left, No. 10 in the middle, and No. 8 at the right. The photograph is one-half actual size.

Having now found the conditions under which these pigments if finely ground would not separate from the oil to an extent noticeable to the unaided eye, we determined the relative fineness of the three pigments by taking photomicrographs of paint on the glass slip, *Fig. 3*, at 100 diameters, at a point in each case ½ inch from the top of the film. *Fig. 4* represents No. 8 paint, and the coarseness of the pigment and the separation of pigment from oil are clearly evident. In *Fig. 5*, representing No. 10 paint, we find a considerable proportion of coarse particles surrounded by a large number of very fine particles, and comparatively small clear oil spaces between the particles. In No. 12 paint, *Fig. 6*, we find very few coarse particles, and an almost unbroken front of very minute particles which almost shut out the bright light immediately behind the microscope. Also, no clear oil spaces are visible in this paint even at this magnification of 100 diameters and at this dilution, and the film was found to consist of particles in several superposed layers, so that practically the entire surface was covered with inert material, and but the barest possible chance offered for the penetration of water and other elements of rust, thus giving a positive answer to the question as to the cause of the relative durability of this paint in service.

Our next step was to build up a pigment having the same properties as No. 12 paint, and this naturally led to a study of the components of the three paints in question. We found that No. 8 paint was composed essentially of calcined metallic brown with hydrated sulphate of lime, in proportions approximately 35 per cent. iron pigment, and 65 per cent. hydrated sulphate of lime.

No. 10 paint consisted of approximately 52 per cent. of hydrated sulphate of lime and 48 per cent. of a natural red sienna, unburnt.

No. 12 paint was composed of natural unburnt ochre, together with about 10 per cent. hydrated sulphate of lime, and 2·4 per cent. tinting material.

Thus, taking the paints in the order of their service values, we note that the greatest durability was found in natural unburned ochre rather low in proportion of sesquioxide of iron (23 per cent.), and with large proportion of clay, and relatively small addition of hydrated sulphate of lime. It is also interesting to note that in this No. 12 pigment, 11·9 per cent. by weight consisted of water, though it was in combination with the clay and sulphate of lime, and not in free condition. The above results thus afford clear proof—in view of the service records—that water, when in proper chemical combination with pigment, does not cause rusting beneath the coating, and also that calcining of pigment is not at all necessary to good service. Upon the other hand, the least durability was found in pigment composed of well calcined material with relatively large proportion of hydrated sulphate of lime; but the lack of durability in that case, as has been shown, was due to the physical condition of the pigment and not to its chemical composition. Hydrated sulphate of lime has been for a long time regarded as an excellent inert paint filler, and our experience has shown that

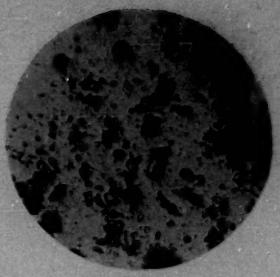

FIG. 4.

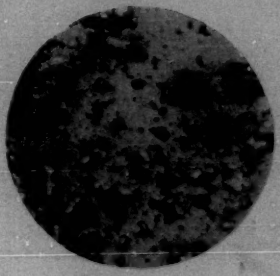

FIG. 5.

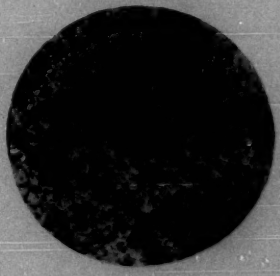

FIG. 6.
Fineness test of standard paints.
(× 100 diameters.)

FIG. 7.

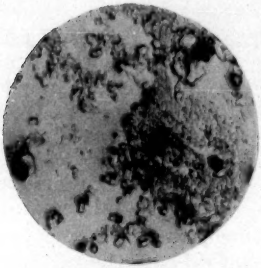

FIG. 10.

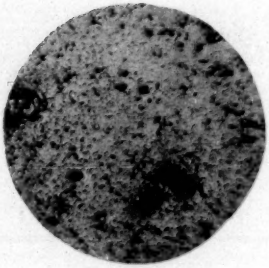

FIG. 8.

FIG. 11.

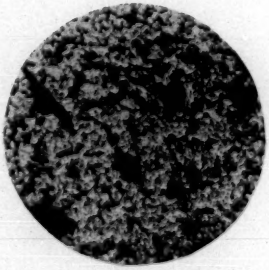

FIG. 9.

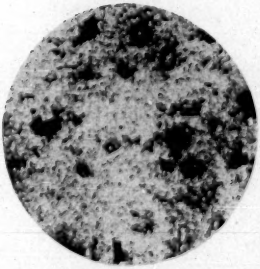

FIG. 12.

Fineness test of "fillers." (× 100 diameters.)

it can be brought to the degree of fineness necessary to enable it to pass the test detailed above, and when in such condition it has given excellent service. We are free to state, however, that the desired degree of fineness can be gained with very much less milling, and hence at lower cost, by use of other materials shown by our service results to be equally inert and durable; but we are perfectly willing to leave the composition of the inert material to the manufacturer, providing merely that it must be inert and of the degree of fineness found necessary and specified.

In order to find out the relative fineness in their commercial form of the various fillers commonly used in paint, we obtained a number of samples, mixed each with the total proportion of raw linseed oil present in the fineness test, *Fig. 3*, subjected it to the fineness test detailed above, and took a photomicrograph at 100 diameters, ½ inch from top of the glass, as in the other cases. *Fig. 7* shows the condition of the finest hydrated sulphate of lime (gypsum) obtainable, and it will be noted that the particles are relatively coarse and granular and are surrounded with large oil spaces. Barium sulphate, *Fig. 8*, is finer to a very marked extent, and the oil spaces, though distinct, are comparatively small. Carbonate of lime (whiting), *Fig. 9*, is one of the finest of the fillers examined, but where exposed to acid fumes is inadmissible. In clay, *Fig. 10*, the majority of the particles are exceedingly fine, though considerable separation has resulted. Silex, *Fig. 11*, contains a relatively large proportion of coarse angular particles, and has also separated considerably. Calcined red oxide had the same general appearance as No. 8 paint, *Fig. 4*. Yellow ochre, *Fig. 12*, was similar in fineness to No. 12 paint, *Fig. 6*, and was the most finely divided of any of the materials examined.

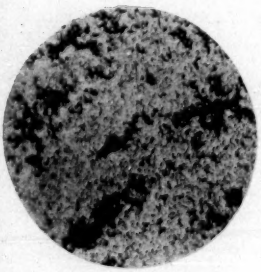

FIG. 13.—New structural paint. (× 100 diameters.)

Fig. 13 represents the condition of our new No. 4 structural paint, at 100 diameters, under the same conditions as in the foregoing. The paint consists of natural soft uncalcined pigment, tinted with a small proportion of carbon black, and ground in raw linseed oil in paste form to pass our standard fineness test. In composition it is essentially the same as No. 12 paint, and, as will be noted, the fineness is even greater than that of the latter (*Fig. 6*).

In conclusion I wish to express my thanks to my assistants, J. B. Young and Charles T. Ressler, for much of the analytical work connected with this investigation. Also, I am indebted to a number of manufacturers of paint for samples specially prepared in working out our standards for structural paints, and for advice and assistance regarding details of manufacture.

READING, PA., February 17, 1904.

DISCUSSION.

MR. CHARLES M. MILLS.—Mr. Chairman: As the durability of paint No. 8 was so inferior to No. 12—No. 8 containing such a large proportion of gypsum—I would ask whether Mr. Job has not found that gypsum is soluble in water, which would tend to explain the destruction of paint No. 8 after the oil had yielded to the atmospheric influences, exposing the pigment to the action of the weather. As a practical matter, in dealing with plaster of paris I have found that it has been sufficiently soluble in water, on one or two occasions, to attract my notice, although I am not a chemist, and am not at this time informed as to the extent to which this material is soluble in water.

Regarding the behavior of paints exposed to the exhausts of locomotives in cases where paints were placed on the under side of overhead bridges, I can state that during my experience with city bridges, while with the Bureau of Surveys of this city, I became convinced that no paint made up to this time, and probably no paint ever to be made, would stand the sand-blast action from the exhaust of locomotives, to say nothing of the gases and heat to which they were subjected when the overhead clearance was low. It

was found that the only way to protect paint exposed to these conditions was to supply sheathing and prevent the direct action of the locomotive exhaust upon the paint. It appeared that wood was the most satisfactory material to use for this purpose, as it seemed to resist the abrasion of the particles of cinders better than metal, having what might be termed a cushion effect, which absorbed the energy in the impact of the particles thrown by the blast against it.

The wood used was white pine, and did not wear away, and to my knowledge never caught fire. Care was taken to have no openings in the sheathing through which large particles of hot cinders could be thrown, which would lodge in crevices of the wood and tend to cause fire.

An examination was made of the sheathing under the bridge over the Philadelphia and Reading Railway at Thirty-first Street and Girard Avenue, and also over the West Chester and Philadelphia Railroad at Forty-ninth Street, after seven years of service. The paint on the bridge over the Philadelphia and Reading Railway was extremely well preserved, the only place where I saw rust was on the corners of some angles and cover plates, where the paint was probably brushed out very thin. At the bridge over the West Chester and Philadelphia Railroad considerable leakage had come down through the floor, and where the water had run over the metal work there was more or less rust. The general condition of the paint on the metal work was good. The paint used on both of these bridges was red lead tinted with lampblack. The sheathing under both of these bridges was entirely closed. It doubtless would have been better for the preservation of the sheathing and also the paint, if some ventilation had been provided for.

The condition of the wood at the Girard Avenue Bridge over the Philadelphia and Reading Railway was excellent, and had retained the paint on the underside of the wood. The woodwork at the Forty-ninth Street Bridge was decayed in some places, doubtless owing to the leakage of water above referred to.

For protection of wooden sheathing exposed as above, I think a paint with an oxide of iron pigment would do as well as anything, but would exclude the use of any paints with pigments of lead and zinc.

MR. HENRY C. STEWART.—Mr. Chairman: I think that the Third Exhibit of Painted Experiments (No. 12) is much more favorable as to lasting qualities, in the ingredients, than either of the others (Nos. 10 or 8). This without reference to the iron contained. Lampblack lasts indefinitely; and clay, owing to its fineness and unctuous characteristics, added materially to the longevity of the pigments.

In regard to the slides showing the deterioration of the oxide of iron extended with gypsum on the painted bridge-upright, the deterioration might have been caused by the pigment having contained free sulphur. The chairman will remember how apt this was to occur years ago when the industry was not understood or the requirements of engineers and the trade so strict as at present.

I remember when a boy, in an interview with the late Col. Samuel Wetherill, the inventor of the American process for making oxide of zinc, that he said he believed a moderate quantity of china clay added to zinc or lead would be beneficial. And I see no reason why it should not be true as to other basic pigments.

Pure oxide of iron is largely used in England for the preservation of structural work, and such practice is undoubtedly built on years (centuries, I might say) of observation, and might be studied by our engineers with profit.

The lasting qualities of pure oxide of iron are similar to those of lampblack. The particles of the pigment being so infinitesimally fine, seem to enter the interstices of the coated object, and so prevent the action of the elements long after the oil has disappeared.

I remember seeing a sign at the southeast corner of Front and Arch Streets, Philadelphia, which had been painted some time between 1776 and 1800, and it was still in good condition in 1876, as far as the lettering of the names was concerned. The wood-work surrounding the names (which were painted with lampblack) had eaten away

to the extent of $\frac{3}{8}$ of an inch. As an object lesson it was very remarkable, and certainly demonstrated the worth of the lampblack upon wood.

MR. ALBERT LUCAS.—Mr. Chairman: I would like to ask whether there was any more noticeable fading of the No. 12 color, containing ocher, than in the other colors—No. 8 and No. 10. The question is raised on account of the fact that we have found by practical experience that paints containing a considerable percentage of ochre have a tendency to blacken or discolor, and I thought that this might possibly be due to the hydration of the ochre, whereby one of the darker oxides of iron would be formed in the paint.

As I understand the chairman's statement, he inferred that the best paints were only those which were composed of compounds which formed insoluble salts with linseed oil and that the presence of various amounts of "fillers" was due to a desire on the part of the manufacturer to increase his profits in the same manner as producers of olive oil, added thereto a certain amount of cottonseed oil as a "filler." I wish that Mr. Job would set the chairman straight regarding the use of so-called "fillers" in paints, and reiterate what has been so clearly demonstrated in the paper, that the presence of a percentage of certain inert, finely ground pigments is not injurious; but, on the contrary, helps to increase the durability and decrease the cost of paints.

Permit me to add that the paper is the clearest and most logical demonstration of the question I have ever heard.

MR. JOHN GRUNDY:—My experience has been that where pure oxide of iron paint (finely ground) is used, and the best linseed oil only, iron would be much better protected than with a pigment containing much calcium sulphate (gypsum). I take it that the reason why No. 12 paint was more durable than No. 8 was because the former had little calcium sulphate and more silica and alumina in a fine state of division. I have always found a finely ground pure iron oxide and good linseed-oil paint was the best for iron work, and I also always found that calcium sulphate, no matter how finely ground, "was like sawdust." I can state that I have always

had an objection to using any kind of lime as a base, as from experience I have found that paint containing calcium sulphate would not stand water, and paint containing calcium carbonate would not stand acid fumes. I have seen a marble tombstone (carbonate of lime) eaten half way in ten years in a cemetery near a chemical works. French ochre and some English ochres containing silica and alumina in a natural fine state of division are good preservatives, while American ochre does not seem so good, as it is naturally very coarse, and when ground seems to contain much free iron ore, which both destroys the shade of the pigment, and also allows the elements and sulphur fumes to act readily on it.

MR. EDWARD T. LONGSTRETH:—I have always held carbonate of lime to be one of the best extenders for paints, for the following reasons: Paris white is the best grade of carbonate of lime that comes into the market for use in the manufacture of paints. This article is produced first by grinding the chalk with water under heavy runners, and the mixture is pumped into a series of vats through which it flows from one to another, leaving a deposit in each. The last vat contains the finest and purest grade of chalk, which is called American paris white.

This product after being allowed to settle, the surplus water is drawn off and the product allowed to dry until it is in condition to be dug out and put in the dry kiln, where steam heat is used to drive off the balance of moisture, after which it is powdered and bolted, when a product of a soft velvety texture and of good body is the result.

The combination of paris white with any color adds a softness to the mass, which, when thinned ready to be brushed upon a surface, flows freely under the brush and leaves a smooth finish.

Pound for pound, paris white used against any other of the pigments that are employed as extenders produce a product of greater body, fineness of texture, also greater bulk, which necessarily means increased covering capacity, and, as paint in paste form is sold by the pound, the deduction naturally is that a paint of the proper density of body and of

greatest bulk will at the same cost be the cheapest product, as thus the covering capacity is greatly increased. Take, for example, two pigments that have been extended 100 per cent., one with carbonate of lime and the other with sulphate of lime; the former will not only be of greater bulk and of better covering properties than the latter; but, with the same amount of thinners, will cover more surface at a less cost per square foot.

Paris white is very durable, as, when mixed with pure linseed oil, it will withstand the action of the elements for some years. Take as example the putty with which we glaze our window-sash (this article is made from the same material as the paris white, although of a coarser grade) and you will note the number of years it will stand, even if unprotected with paint.

MR. WALTER S. DAVIS.—Mr. Chairman: As to the effect of water combined with the pigment upon service value, my experience also has been that it is not deleterious or objectionable. I have found, too, that its exclusion very materially impaired the working qualities of the paint, and this, I believe, was practically tested and fully verified by Dr. Dudley some years since.

All of the discussions of the evening have confirmed the opinion expressed in the paper regarding the grinding of sulphate of lime to a point where its granular appearance would not be so marked. Its structure, as we know, is different from clay. There is no amount of milling that will take it out of its granular condition, while clay can be readily milled to where it produces a plastic rather than a granular coating. The plastic coating is certainly the desirable one for the exclusion of moisture, as was so completely evidenced by the photomicrographs showing the No. 12 paint.

MR. W. B. REIGNER:—Referring to the method used some years ago, to protect the metal work of the bridge carrying Broad Street and Lehigh Avenue over the Reading Railway, a plaster coat about $\frac{1}{2}$ inch thick was applied to corrugated iron lath which was laid on light metal framework attached to the bottom flanges of the girders, the entire

under-surface of the structure being thus closed against the action of the locomotive fumes. The construction was not satisfactory, owing to its not having sufficient strength to withstand the force of the exhaust from engines. The clearance above the rail was only 16 feet, and there is a grade in the track which gave increased effect to the exhaust. In a short time the plaster became loose and began to fall upon the track, requiring the whole to be removed. Had the construction been of sufficient strength, it would doubtless have answered its purpose for a considerable time.

DR. HENRY LEFFMANN:—I have always understood that the durability of a paint is largely dependent on the formation of compound by the action of the oil upon the admixed solid material. This compound is of the nature of soap and its formation involves the oxidation of the oil to acidulous bodies. Hence, the best materials for admixture with oil will be those mildly basic, and capable of forming soaps that are insoluble in water. The opacity of the solid matter influences the covering power of the paint, which is of considerable practical importance. These qualities are possessed in a high degree by white lead. It has been held by most experts in this field that white lead in linseed oil is the best paint. I have always thought that gypsum found its way into paint only as an adulterant, and that ferric oxide is used as a cheap substitute for white lead, although, of course, color requirements often necessitate a departure from the white-lead-linseed-oil mixture.

From a theoretic point of view I would regard barytes as superior to gypsum, as the latter is slightly soluble in water, and decomposed by ammonia carbonate, which may be present in rain-water.

MR. JOB:—As to solubility of gypsum, Watts states that it is very slightly soluble in water, different authorities varying from 1 part gypsum in 400 parts water, to 500 parts water. Hurst gives the solubility as about 1 part in 500 parts of water, and states that upon exposure to light and air, gypsum is unaffected, being one of the most permanent pigments known. ("Painters' Colors, Oils and Varnishes," page 80, second edition.) It is undoubtedly true, we

think, that this slight solubility shortens somewhat the effective protection where gypsum is present in large proportion in the pigment, but where the proportion is moderate the influence would probably be very slight, since each particle if properly ground would be protected by the other inert matter, and thus the ordinary slight solubility would be very much lessened.

It is of course perfectly possible that the poor service of No. 8 paint may have been due to a slight extent to the solubility of the sulphate of lime, but in the case of No. 10 paint we have nearly as large a proportion as in No. 8, but far better service. Moreover, in our service we have had under long exposure paints which contained fair proportions of sulphate of lime, and the durability of the coating has been good in cases where the fineness was of the degree stated in the paper.

We fully concur in the experience of Mr. Davis and Mr. Grundy as to the difficulty of getting the desired degree of fineness with this pigment, but in our specifications for Structural Paints, to which reference has been made, we have not barred out sulphate of lime provided it is ground finely enough to pass our fineness test. As a matter of fact, however, very little, if any, gypsum will be found in these shipments, since it is practically shut out, from the standpoint of the manufacturer, by the cost of milling it to the degree of fineness specified.

As to carbonate of lime, our results have shown that it is inadmissible where exposed to acid fumes—as strikingly illustrated by Mr. Grundy. In our black car paint, used upon coal cars, we have, however, specified from 10 to 15 per cent. of whiting in order to increase the fineness of the sulphate-of-lime base, and the results have been fairly good, but we shall probably revise this practice and gain increased fineness by use of other materials and thereby increase the durability without increasing the cost of the paint.

In reply to Mr. Lucas, I can state that the degree of fading of the three paints was slight and about the same. There was a slight lightening of the shade in each case on long exposure.

In order to get the effect of exposure and warmth upon the pigment itself without oil, we spread out a layer of each pigment in a large watch glass, and kept upon the steam table at a temperature of 150° F. for about two weeks, we then mixed with oil and made comparison under glass with the original pigment also rubbed up in oil. In each case we found a slight lightening of the shade, about the same as found in service. The darkening mentioned by Mr. Lucas might perhaps be due to partial dehydration, though it seems unlikely that a temperature sufficiently high to effect this change would be met in ordinary service. Possibly the action of sulphur fumes may have had an influence.

As regards the question of inert matter, we can do no better than quote the important papers of Dudley and Pease, to which reference has already been made: *"All we can say is that we try to use as much pigment which from its nature is chemically inert, and as little pigment which is chemically active, as possible. To our mind, the well known fact that white lead mixed with barytes or other inert material lasts longer than pure white lead is explained on the supposition that the white lead combines chemically with the oil, forming a chemical body which is not as durable as dried linseed oil with an inert pigment." And again: †"A mixture of two pigments of good and inferior covering power can be made which will give almost if not quite as good covering power as if the paint was made wholly of the better pigment."

‡"The law, as we understand it, is this: 'you may use as much inert material as will leave good optical covering power when the paint is properly mixed and applied.'"

The above is clear and to the point, and is in thorough accord with the teachings of our service results in cases where the pigment was of the degree of fineness stated in this paper, and it will be noted that our No. 12 paint, which gave excellent service, was composed of 75 per cent.

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* *American Engineer and Railroad Journal*, September, 1890, page 416.
† *American Engineer and Railroad Journal*, February, 1891, page 82.
‡ *American Engineer and Railroad Journal*, April, 1891, page 176.

of inert matter, and only 25 per cent. of material even slightly chemically active. As has been shown above, the difference between success and failure in the service of such paint ground in pure linseed oil and properly applied lies in the mechanical condition of the pigment—a matter which can be easily regulated.

As to the composition of No. 8, No. 10 and No. 12 paints, we agree with Mr. Stewart that that of the latter is the most favorable of the three, due to the presence of the larger proportion of clay, the cause being, we think, not any especial virtue in clay itself, but the fact that clay of good quality consists of matter chemically inert, practically insoluble and in an almost impalpable state of fineness, and consequently it is in a condition from which efficiency would be expected even without milling. In the No. 12 paint no lampblack was present, and only 0·2 per cent. of carbon black—too small a proportion to have any influence upon the service. Careful test was made of each pigment, but no free sulphuric acid was found.

When exposed at short range to the sand blast of exhaust of locomotives, our experience tallies with that of Mr. Mills, for we have found no paint which has great durability under such conditions. It is possible that reinforced concrete may bring a solution of this problem.

Through the kindness of Mr. Stewart we received samples of pure red oxide pigments such as used abroad upon structural work, and found that one sample, containing 97·50 per cent. sesquioxide of iron, fully met our requirements for fineness, and was of very good quality throughout. Such a pigment, if properly prepared, would without question give good service results. Our main criticism would be that it would cost more and would probably give less efficient service than if diluted with sufficiently fine inert matter of good quality. Cost of paint is an important matter of consideration to the large consumer, and one fact clearly emphasized by this study is that durability and low cost can be made coincident.

DR. C. B. DUDLEY (correspondence):—If I understand the matter rightly, the point which Mr. Job has apparently

developed, is that fineness of the pigment is a very important element in the durability of the paint. We believe very few will object to this view, and it looks to us as though this paper is a decided call on the paint manufacturers to give us finer pigments.

In this connection it may not be amiss to say that for a long time it has been out belief, supported by some experimental evidence, that pigments can be made fine in the dry condition much cheaper than they can after they are mixed with the oil. In other words, the making of pigment fine should precede the mixing with the oil, and the mill, which has heretofore been used to make the pigment fine, should be used simply as a means of mixing the pigment and oil together. With some of the devices which are now on the market for getting fineness, it has for some time impressed us that the paint people were not living up to their advantages in the matter of making pigment fine.

One point further. While we all agree that it is advantageous to have the pigment in paint very fine, it should be remembered that the finer the pigment the slower the paint dries, and that, of course, there is a point which cannot be exceeded without running into the difficulty of slow drying. Our experience with the paints in the market, however, indicates that we are very far short of that point at the present time.

MR. JOB:—Dr. Dudley's belief that pigments can be made fine in the dry condition much cheaper than they can after they are mixed with oil is directly in line with our own experience, and, as referred to in the paper, we have found that the desired degree of fineness can be obtained with very much less grinding, and hence at lower mill cost, by use of inert materials which occur in a natural state of extreme fineness, and hence require little more than thorough mixing with oil of good quality to make into serviceable protective paint, and such materials can be obtained upon the open market at relatively low cost. We have also found that pigment of less initial fineness can be brought to the desired condition more economically by grinding without addition of oil, the reason being, we take it, that when oil is

present its viscosity prevents the milling surfaces from coming into close contact, and hence shuts out the chance for the degree of fineness of pigment otherwise obtainable.

Fineness of pigment certainly has a decided influence upon time of drying, as, for instance, in pure lampblack paint (to cite an extreme case); but with the ordinary inorganic pigment, the degree of fineness is so far below the latter standard that not the slightest difficulty due to slow drying is found when the pigment is even finer than in the No. 12 paint referred to above. In use of that paint, a dry coating could be obtained in eight hours when necessary, but we think it better practice to use the minimum proportion of japan and allow a longer time for drying.

COMPARATIVE COST OF WATER POWER.

The cost of water power development in France, according to Professor Janet, varies from $21.40 per horse-power to $150 per horse-power, depending on the head to be dealt with, the lowest expenditure being upon a fall of 140 meters in Haute-Savoie, the horse-power being calculated at the turbine shaft. At Geneva, for the first group of turbines erected, of 840 horse-power, and for the river works then completed, the capital cost amounted to $300 per effective horse-power. The groups of turbines subsequently erected cost but $95 per horse-power, and the completed works would cost but $135 per horse-power. At the chlorate works at Valorbe, the capital expenditure upon the development of 3,000 horse-power amounted to only $19.45 per horse-power. At Niagara, the rates charged to ordinary consumers by the Cataract Power and Conduit Company varied from 2 cents per unit for 1,000 units per month or less to 0·64 cent. per unit for 80,000 to 200,000 units per month. The cost of energy for power purposes from water-power stations in France and Switzerland varied from 2·1 cents per unit for small powers to 1·24 cents per unit for large powers.

THE ELMORE COPPER WORKS AT SCHLADERN.

The electrolytic copper-tube works at Schladern, Germany, employing the Elmore process, are turning out about 1,500,000 kilograms of copper tubes a year (*Oesterreichische Zeitschrift für Berg- u. Hüttenwesen*, December 19, 1903). The precipitation is effected in lead-lined wooden boxes, 6 meters by 2 meters broad, the bottoms of which are first covered to a depth of 200 millimeters with granulated copper, and which are then filled with a solution of copper sulphate containing 3 per cent. of free sulphuric acid. Each box is provided with one or more horizontal spindles placed about 30 millimeters above the layer of granulated copper, which receive a rotary motion from a

shaft under the boxes. The electric current is transmitted to the metallic copper, passes through the solution to the spindles and is then conducted to the next box in the series. The current strength averages 200 amperes at from 40 to 50 volts. All sizes of tubes up to 2·5 meters in diameter and 6 meters long are made. They are said to be remarkably uniform as regards strength, and are fully equal in this respect to cold-bored tubes.

DECLINE OF METALLIFEROUS MINING IN GREAT BRITAIN.

In the course of his review of mine company registration during 1903, appearing in the London *Mining Journal*, Mr. Edward Ashmead points out that only five small companies appear in the list for Cornwall, and he then proceeds to say:

"The most deplorable thing in connection with mining is the low ebb to which British metalliferous mining is reduced. From being one of the most flourishing of industries, it has dwindled down to almost the vanishing point. Great Britain never claimed to be a gold-producing country, but for tin, copper, lead and zinc it was, within the memories of many of those living, able to produce, not only all of these metals required for home use, but even to export part of its production to foreign countries. For some time now Great Britain has been gradually closing down its own mines, and helping somewhat largely to find the means to open those in other countries. According to the mineral statistics of the United Kingdom, compiled by the late Mr. Robert Hunt, we had in the year 1881 no less than 95 mines working and producing tin (all in the two western counties), 68 producing copper, 250 producing lead and 50 producing zinc, making no less than 463 mines producing these four metals alone. The product of these mines not only added directly to the wealth of the nation, but gave honest and constant employment to thousands of hands. Turning to my own tables, I find that in the three years 1881–3, 166 companies for working metalliferous mines were registered at Somerset House, having a total capital of £7,726,566. Twenty years later, 1901–3, only 36 companies were registered, and the united capital fell to £1,044,350."

NEWEST ADDITIONS TO THE U. S. NAVY.

The three 16,000-ton battleships recently authorized by Congress are to have the following dimensions: Length between perpendiculars, 450 feet; length over all, 456 feet 4 inches; extreme breadth, 76 feet 8 inches; depth, 46 feet; draft of water, 24 feet 6 inches. The hull will be plated with ½-inch steel, with a double bottom. A cofferdam 7 feet high and 30 inches wide, filled with corn pith cellulose, and located back of the armor belt, protects the water line. The power equipment includes twelve water-tube boilers, having a total heating surface of 46,750 square feet, and a grate surface of 1,100 square feet; they will carry a pressure of 265 pounds to the square inch. Two triple expansion engines with four cylinders each will drive the vessel at a speed of 18 knots. The cylinders will be 32½, 53, 61 and 61 inches in diameter by 48-inch stroke. The total power of both engines, at 120 revolutions per minute, is 16,500 horse-power.

THE FRANKLIN INSTITUTE.

Stated Meeting, held Wednesday, November 18, 1903.

The Utilization and Disposal of Municipal Waste.

By Wm. F. Morse, Sanitary Engineer, New York City, N. Y.
Member of the Institute.

(*Concluded from vol. clvii, p. 423.*)

CREMATION OF WASTE IN THE UNITED STATES.

The beginning of garbage cremation in the United States was made at *Governor's Island in New York harbor* about 1877, when an officer of the army caused to be built a rectangular brick structure with a chimney in the back connected with the interior of the furnace. Only kitchen waste was consumed in this crematory, being deposited upon two slanting iron grates. The fire-boxes of the furnace were placed below and between the grate bars. This primitive crematory has been in use, with some changes and many repairs, ever since it was built, and is only now about to be replaced by a destructor of modern type.

In 1877 Andrew Engle, of Des Moines, invented what was known as the *Engle Cremator*, which in its simplest form of construction was a square brick structure, its height and width nearly one-third of its length. This furnace had transverse grate bars and a fire-box at each end. In the upper chamber the material to be consumed was placed on the transverse bars, and the main fire was supplemented by a secondary fire at the other end of the furnace. This principle of the secondary fire is common to all crematories of the American type. The Engle crematory reached its highest point of development at the World's Fair at Chicago in 1893, where two furnaces of this type destroyed all the garbage and sewage sludge resulting from the presence at the Fair grounds of over twenty-seven million persons during the six months of the Exposition. The work was performed in a perfectly efficient and sanitary manner, but it was ex-

pensive because of the peculiar conditions, and of the nature of the waste destroyed.

About fifty crematories of the Engle pattern were built, some of which are still in use; the most notable example being at *Norfolk, Va.*, where in ten years 60,000 tons of kitchen waste have been consumed at the cost of 50 cents per ton, including all charges for fuel, labor and repairs.

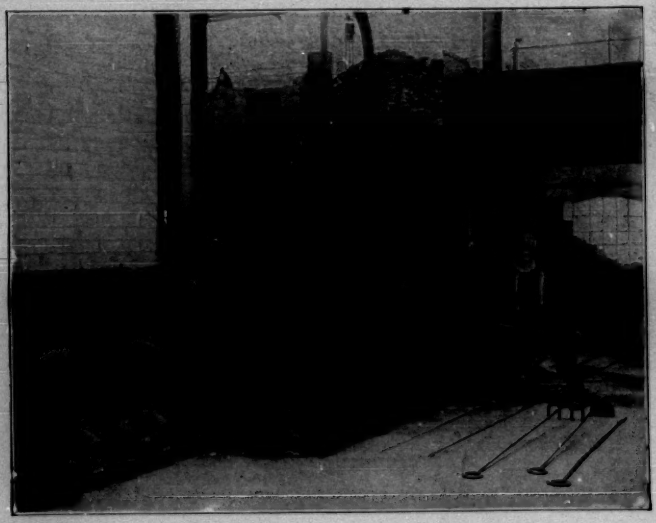

FIG. 10.—Clinkering Meldrum destructor, Llandudno, England.

The *Dixon Sanitary Crematory* originated in Finlay, O., in 1894. In its original form it was an imitation of the Engle furnace. Under new patents the construction was subsequently changed, but it preserved the original features of two grates and three fires for the destruction of the garbage and the gases therefrom. Some thirty examples of the Dixon crematory have been constructed, not all of which are now in use.

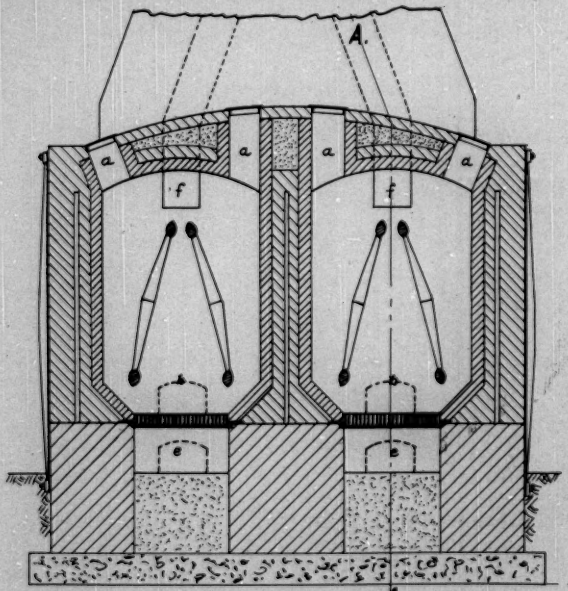

FIG. 11.—First crematory built in United States, 1877-78.

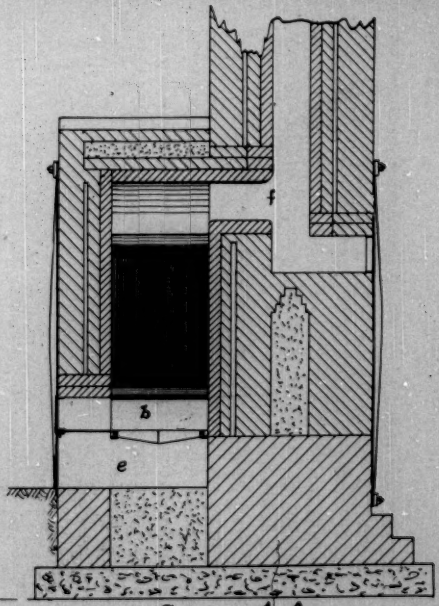

FIG. 12.—First crematory, United States. Section.

Following the same lines of invention came the *Smith-Siemens*, of which one installation is now operating; the *Vivartas Cremating Furnace*, with one example operating; the *Brownlee Crematory*, with one example; the *Thackeray Incinerator*, with two examples operating; and the *Decarie Garbage Incinerator*, with one furnace in active operation. The roster of cremating furnaces built in this country for municipal purposes includes, down to the present time, something like seventy-five to eighty examples, and covers a period of seventeen years. Only about forty of these installations are operating at the time of writing. The list of the names of inventors includes many who, confident of the powers of their inventions, have succeeded in persuading city governments to erect experimental plants, the majority

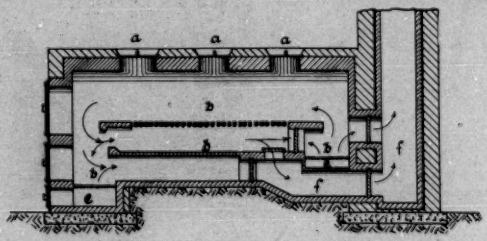

FIG. 13.—The Engle cremator, 1887.

of which have been failures—the failures, in fact, keeping pace with the number of installations accomplished.

PRESENT SITUATION IN THE UNITED STATES.

To day we are almost exactly in the same position as the English towns were in before the adoption of their present methods of disposing of waste by the aid of forced draft. The American cremating furnaces operating under natural draft can attain only a low temperature, and must do this by the use of fuel in considerable quantities.

Another, and perhaps the chief, reason for the slow progress made in the art of waste disposal in this country, is the fact that municipalities allow the work to pass into the hands of contractors, or corporations, who look at the

matter from a financial viewpoint only. There is no doubt that contractors can usually do the work more cheaply than the city can do it, and that when they are given an opportunity for the performance of this work for a term of years they are in a position to do it for considerably less than the city possibly could. It is their policy, however, to do as little work as possible and to get as much money for it as they can.

Again, the initial steps in disposal work are usually taken by the gentlemen of the City Councils and the Health

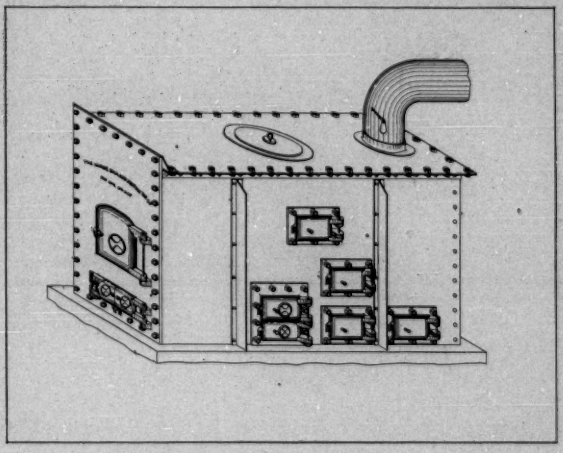

FIG. 14.—Morse-Boulger destructor, 1895–96 (small size). Standard No. 1.

Department, who are usually without the technical education and experience necessary for the correct solution of an engineering problem of this character, and who have to accept estimates made for them without having the benefit of previous knowledge, or of expert advice. Probably to this fact alone are due a large part of the failures of crematories that have occurred in this country. It is obvious that if any substantial progress is to be made, there must be radical changes in the methods of construction and in the

development of engineering skill, and a more intelligent examination of the methods which it is proposed to employ.

DEVELOPMENT OF INSTITUTIONAL DESTRUCTORS.

There is another side to the matter which is being developed more rapidly than any other phase of the disposal question. This is the disposal of the waste of large build-

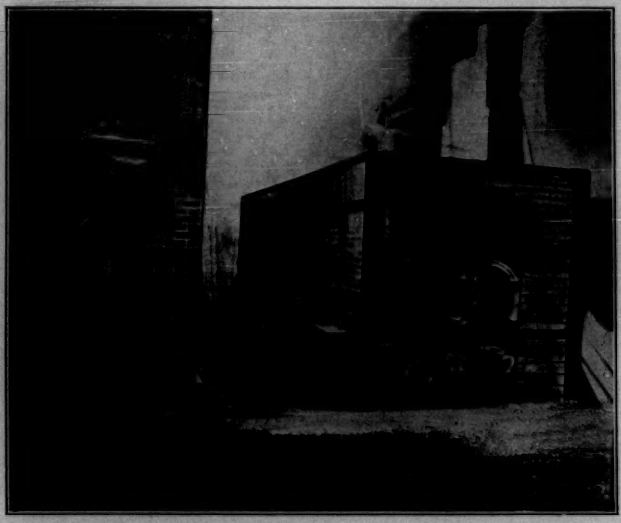

FIG. 15.—Morse-Boulger destructor, with Green's economizer, Lit's department store, Philadelphia.

ings such as hotels, hospitals and sanitariums, business establishments such as department stores and factories, and private buildings. It has been found practicable to install destructor furnaces of sizes proportionate to the amount of waste produced in the building, to be operated by the engineers and firemen regularly employed in the boiler room of the establishment. The heat derived from the cremation of the waste is applied to the production of steam power for

the purpose of heating feed water for the boilers, or for any other purpose of the machinery equipment.

A Morse-Boulger Destructor is installed in one of the largest department stores in Philadelphia. The waste is

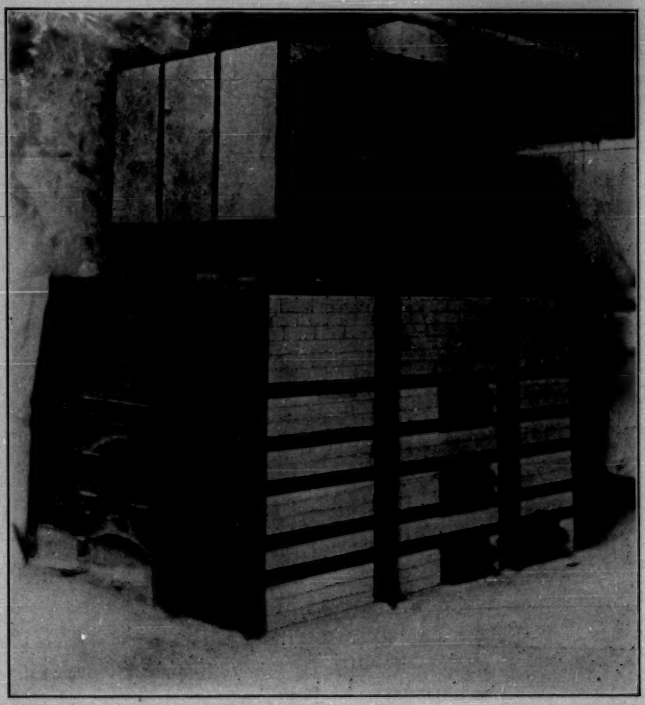

FIG. 16.—Morse-Boulger destructor, Broad Street Station, Penna. R. R., Phila.

brought from the upper floors of the building through chutes to a room in the basement, and after preliminary sorting and recovery of the more valuable portions the remainder is charged into the furnace. The heat derived

from combustion of this waste is passed into a Green's Economizer which heats the feed water of a boiler battery

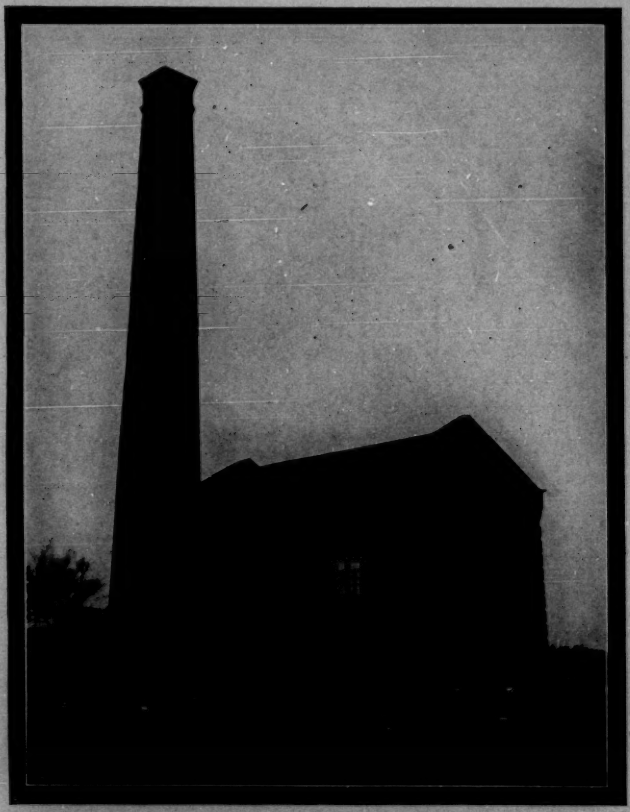

FIG. 17.—Morse-Boulger destructor, U. S. Navy Yard, Philadelphia. Exterior.

of 750 horse-power, raised by this means to a temperature of 280°.

This example demonstrates the utilization of heat generated by the combustion of worthless refuse, and is a striking instance of the utility of a method which saves practically from 2 to 3 tons of coal per day. The heat may also be utilized by the addition of a steam boiler to the destructor, the power from which is used as auxiliary to the main steam plant, or for independent purposes. Some of

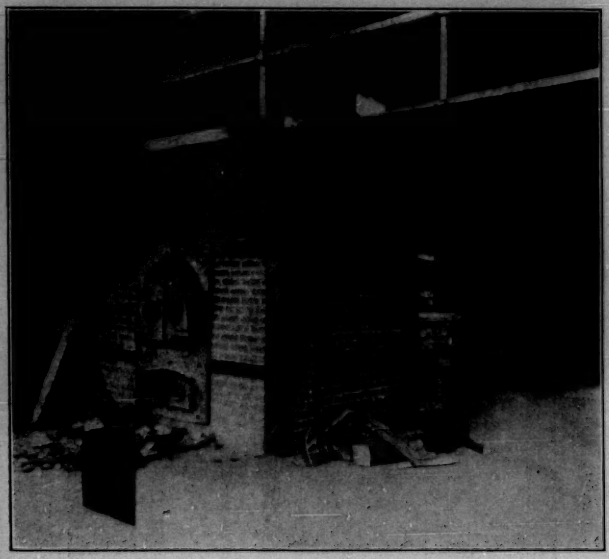

FIG. 18.—Morse-Boulger destructor, U. S. Navy Yard, Philadelphia. Interior.

the largest hotels in this country have adopted this method of heat utilization.

The United States Government has recognized the value and efficiency of these destructors, and has installed them in navy yards, army posts, sanitariums and hospitals, and at the Immigrant Station in New York harbor. At the present time something like sixty examples of the Morse-

Boulger Destructor form of construction are operating, and are used for the disposal of waste of every character,

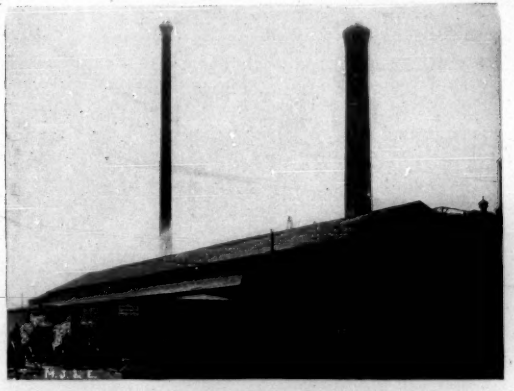

FIG. 19.—Refuse Utilization Station, Boston.

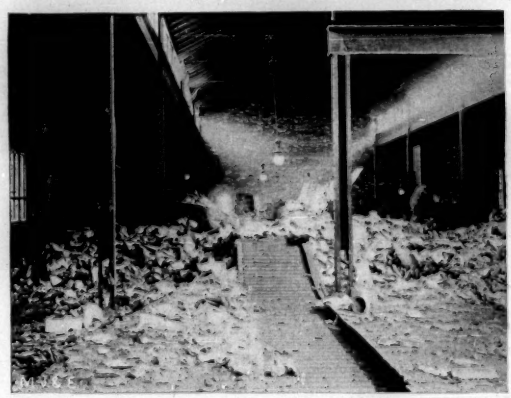

FIG. 20.—Refuse Utilization Station (receiving and sorting floor), Boston.

including the rejected matter from medical schools. They are installed in the basements of stores, and destroy what-

ever kind of waste is placed therein with entire efficiency, and with absolute sanitary results, and with economy in operation which mark them as a leading feature of the sanitary equipment of the establishments.

All this work in small furnaces has been accomplished within the last three years, and has been marked by the adoption of this one particular form of furnace.

The largest example of a destructor of this kind has been operating for some time in Manila, Philippine Islands, where, in 1902, a destructor of the *Morse-Boulger* type, with the capacity of 130 tons per day, was built. This destructor

FIG. 21.—Refuse Utilization Station (power and hand presses) Boston.

is supplied with forced draft furnished by the utilization of its own heat, and by this means it is able to operate with the consumption of the least amount of fuel required by any American furnace built for this purpose.

THE RECOVERY AND UTILIZATION OF WASTE SUBSTANCES.

In our examination of this subject one more form of construction appears, that which is adapted to the recovery and sale of such portions of refuse as are marketable, and the destruction of the remainder, valueless except for the production of heat. The methods instituted by Col. G. E.

Waring resulting from the experiments conducted by him have been found to be practicable for the treatment of the rubbish of any northern town.

The 10 or 12 per cent. of waste, and the volume of rubbish which is annually produced comprise a great bulk of articles and substances which are valuable if they can be recovered in a condition reasonably free from dirt. The paper annually manufactured and used in the United States is sufficient to supply every inhabitant with 50 pounds of

FIG. 22.—Refuse Utilization Station (the Morse-Boulger destructor, conveyer, boiler, engine, dynamo), Boston.

paper per year. In most northern cities the ratio of production of rubbish (which includes the paper rubbish, the most valuable part) is one ton of refuse daily to each 10,000 persons.

Colonel Waring introduced a system under which this paper was separately collected by city carts and brought to one central point in the collection district, and there spread upon a moving platform which passed between a line of

men stationed on either side, who recovered from the waste such parts as might be utilized or worked over into marketable articles. The worthless remainder was then carried by the moving belt down to the furnace, and the heat resulting from the combustion of this material was utilized for moving the machinery of the plant.

This method has been in use in Boston for five years at the Atlantic Avenue Refuse Utilization Station, where, within half a mile of the City Hall, from 25 to 30 tons per day of combustible refuse are sorted over and the worthless residuum consumed in the *Morse-Boulger Destructor* without offense. The heat is utilized and applied to the purposes of moving the machinery and of lighting and warming the entire plant.

THE APPLICATION OF THESE METHODS TO THE REQUIREMENTS OF PHILADELPHIA.

Application of the foregoing descriptions of disposal of waste by the method of cremation may be briefly made to the conditions in Philadelphia in the following manner:

In 1902 there was collected from the streets of the city an amount of waste consisting of garbage, ashes and street sweepings represented in round figures by 823,977 tons. Of this proportion about 280,000 tons represent the garbage disposed of by the reduction process. The amount paid by the city for this work was $490,000. This was an increase over the expenditures of 1901 of $50,000, and an increase of $43,000 over the expenditures of 1900. This shows, therefore, that the total cost of collection and disposal increased $93,000 in two years for garbage only.

The total payment for the collection and disposal of ashes and street sweepings was $720,890. In one year this increased $125,000, and in two years $65,000 more, making a total increase of $191,000 in three years for ashes and refuse.

The refuse collection in 1901 amounted to 15,000 loads. In 1902 it was practically the same; but in 1903 it was 30,000 loads, an increase of 15,000 loads in three years.

The total amount of the bulk of the city waste was 823,977 tons. If the methods employed in England were

FIG. 23.—A Philadelphia refuse dump.

FIG. 24.—The recovered material at a Philadelphia refuse dump.

applied to the destruction of the waste of Philadelphia, it would be done by the erection in four quarters of the city of large plants completely equipped and supplied with furnaces of large capacity, furnished with steam boilers developing steam power by the combustion of the mixed municipal waste. As one pound of water is evaporated for every pound of waste, this would develop 10,000 horse-power daily for 365 days in the year. But as the conditions may vary somewhat from those of the English cities, it would be fair to assume that one-half of this quantity of water would be evaporated, giving a daily horse-power of 5,026. The value of this horse-power calculated in electrical units would be 157,800 British Board of Trade units. The average candle-power of this steam would be equal to 152,960 incandescent lamps of 8-candle power.

Our conditions may be somewhat different from those of the British towns; but the fact remains that the city of Philadelphia can destroy its 900,000 tons of municipal waste by cremation in a satisfactory, entirely sanitary manner, and can develop power thereby, which, when applied to electric lighting, will serve to illuminate a very large area, certainly one-third of the city. These calculations are proved by the practice of the English cities, where in sixty-three cases the power obtained from the combustion of the city waste is applied as auxiliary to the electric lighting stations.

The last consideration, and one of the most practical moment in Philadelphia, is the disposition of the rubbish, which, as has been shown by the work done in Boston, is a matter of great present importance. Take the 30,000 loads that were collected last year by the street-cleaning department, taken to the various city dumps, and there disposed of in a very unsanitary and extravagant way; suppose that instead of being distributed broadcast over the dumps these loads were taken to three stations, the city being divided into three districts, and the loads delivered direct to the stations by the contractors, or by the city teams. There would be erected three refuse utilization stations similar to those now in operation in Boston and in New York, each of which would have 10,000 loads to dispose of yearly. If we

reckon the saving to be had, as shown by the work in Boston and New York City, we may say one-half of this waste may be turned into money by the agency of the various stations erected by the municipality. This amount would be represented by $40,000 per year, derived from the sale of the marketable portions of the waste. There would also be the surplus steam power obtained from the destruction of the worthless parts of this refuse, which could be transformed into electric power, or put to some other use, or conveyed and sold to manufacturers.

The work in Boston shows that after five years' service the steam power produced by the destruction of the worthless portions of refuse is more than sufficient to do the work required by the machinery of the station. This seems to be the practical idea of the destruction of waste matter as applied to the conditions of the city of Philadelphia. Suppose that the city were to build three stations of this character; suppose that, as in New York, the city should invest money in these plants, say, roughly speaking, $125,000, that these plants were operated by contract, the revenue to the city would be at the rate of $1.00 per ton, the expenses of the plant would be defrayed, and there would be left sufficient margin to reimburse the contractor for operating the station. In other words, the city would by its own action bring into use an agency for the abolition of the objections made to the dumps, would be repaid for its outlay, and in three or four years have three completely equipped refuse disposal stations for future service that would return a revenue in increasing measure every year.

The Street-cleaning Commissioner in New York reports that from one station of this kind, where the average daily receipts are 30 tons, the return in money to the city is about $250 per week in cash, and an equivalent amount in the saving of transportation expenses. This is sufficient proof that the work is not only sanitary and practical, but that it is also one in which the city can engage with absolute certainty of protecting itself against financial loss.

This method of dealing with refuse has already attracted the attention of other cities besides Boston. New York is

about to construct a second disposal station; St. Louis will follow with two stations; and Buffalo has now under contract the building of one large central station, at which the steam power developed by the combustion of the worthless parts of refuse will be utilized to pump the sewage from a large area of the city.

In conclusion, waste disposal methods in the United States are at present in a transition stage. Thus far the experiments of individual inventors or municipalities in the construction and operation of disposal plants have not been altogether satisfactory. With but limited success large amounts of money and years of time have been spent in efforts to obtain lucrative and sanitary reduction processes, or odorless, economical and durable crematories. Although reduction methods have been adopted by contract with private parties in several cities, their general adoption is likely to be very slow, as they require a large sum for establishment, and there is no certainty of their continuance except by means that constitute a practical monopoly.

Thorough examination of the requirements of a city by technically skilled men, and the unbiased and carefully considered recommendations of approved methods by competent engineers to the city authorities would give the whole subject the standing and character which it now lacks. The disposal of waste should be considered as much a part of necessary municipal work as any other department of the city government, and it should be approached with the respect and consideration that the magnitude of the financial interests and the laws of sanitation involved may demand.

Under these conditions progress can be secured and upheld. By the power of these agencies working together for a common purpose, the elimination of worthless and dangerous matter in a safe and economical way can be established and maintained, and the proper methods become important factors for the preservation of the comfort and health of American communities.

Mechanical and Engineering Section.

Stated Meeting, held Thursday, October 22, 1903.

Modern Expanding and Flanging Machinery and Tools.

By Luther D. Lovekin,
Chief Engineer, New York Shipbuilding Company, Camden, N. J.

(*Concluded from vol. clvii, p. 435.*)

TOOLS FOR CLASS "A" SIZE MACHINE.

The above-mentioned tools consist of a steel casting shank and body, in one piece, bored out to receive a forged steel mandrel, as shown in *Fig. 4*, and the body is slotted out to suit the feeding screw *F*, in order to give the inner mandrel *E* the proper movement necessary for expanding. The feeding screw *F* engages into the feeding wheel *G*, and, as will be seen, any movement of wheel *G* causes the feed screw *F* to move outward or inward as desired. Feeding wheel *G* is held in place by a nut at the rear end; this nut also takes the thrust due to forcing the expanding and flaring rollers ahead, and is also provided with a facing at the rear end, which when unscrewing from the mandrel proper, comes in contact with the socket head on machine, and thus makes a very useful device for withdrawing the tool shank. The shank is provided with suitable feather and set screw for holding tool in place, and the end of shank comes in contact with the bottom of the bore in socket, thus giving a very firm backing for the tool proper, in case of excessive end thrust.

As will be seen, the shank is arranged at its front end to receive a series of detachable heads to suit the various sizes of pipes. These heads are made of steel castings suitably bored for the end of the shank on body of tool, and are also provided with suitable key-way and feather in addition to the set screw as shown. Each head has a series of slots, suitably finished to receive the expanding and flaring rollers, and the said rollers are held in place by means of set screws, as shown. All faces on the heads com-

ing in contact with rollers are hardened to insure lasting qualities.

The central rollers are mounted freely on the reduced portion of mandrel *E*, and are provided with suitable anti-friction washers at their rear end to absorb the thrust. These rollers are of tool steel, hardened, and are held in place by suitable nut and washer at the end of the mandrel, as shown.

The principle embodied in this expander is that of a central revolving roller, upon which operate the expanding

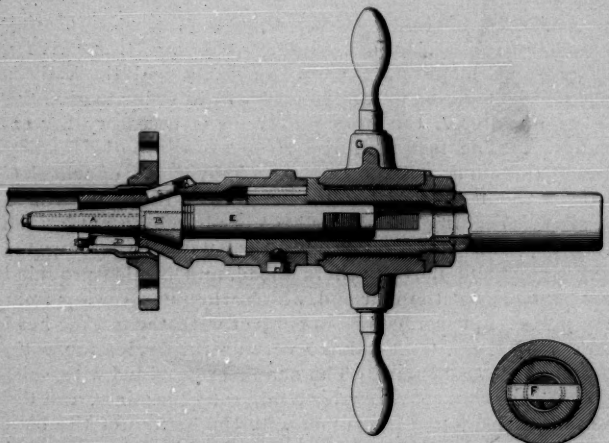

FIG. 4.—Showing principle of construction of the tools.

rollers; the mandrel having no work to perform further than forcing the central rollers outward and inward, as desired, they are therefore not subjected to the immense torsional stresses of other types, which constantly require new mandrels. These central rollers have no bearing on the mandrel whatever.

It will be readily seen from the description given that the operation of expanding is very simple; thus, after the tool is in position in the machine and the pipe and flange set cen-

tral with the spindle, all that is required is to start the motor on the machine which revolves the tool. The expanding is done by simply holding the feeding wheel fast, as this advances the inner mandrel, which causes the rollers to expand. Turning this feeding wheel in the reverse direction causes the rollers to collapse. The expanding tool will be found desirable when setting the pipe central; thus, in order to insure the "V" grips being properly adjusted, it is well to advance the tool inside the pipe and expand out enough to hold the pipe central, then examine the "V" grips and the jaws to see if the bottom of the grooves are at least $\frac{1}{8}$ of an inch clear at the side of the flange; then adjust the "V"

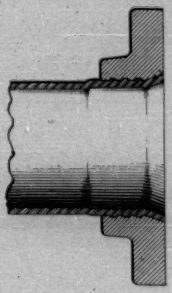

FIG. 5.

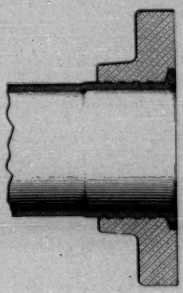

FIG. 6.

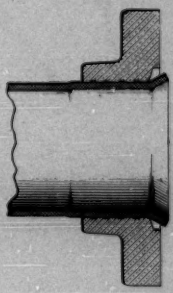

FIG. 6a.

grips to come in contact with the pipe (while this side clearance is maintaind in the jaws, clamp "V" grips solid to jaw); release the expander and grip the pipe firmly by turning the hand wheel provided for such. This operation is only necessary when setting the first piece of pipe, in order to avoid any mistake, as when once set for a certain size flange and pipe, all others of the same size can be set completely ready for expanding in about two minutes' time.

Fig. 5 shows a sample of bilge and ballast piping for vessels. This same joint is used for oil mains throughout the country, and will also pass the United States inspectors' rules for steam piping.

Fig. 6 shows the most recent method of rolling copper

and steel piping in flanges, for both United States Navy and the Board of Supervising Inspectors of Steamboats in the United States.

Fig. 6a shows the amount of work done by the expanding and flaring tools in all copper pipe work, thus leaving the coppersmith to finish the joint, as shown in *Fig. 6*, by simply hammering the ends down into the recess. This is done so as to avoid the necessity of having too many different-shaped tools on hand, the work of finishing up such a joint requiring but a few minutes to perform. It is well known that the expanding takes up at least 90 per

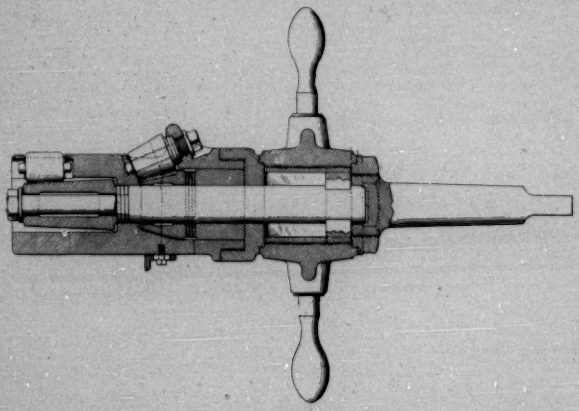

FIG. 7.—Lovekin patent expanding and flaring tool with cutter for all piping.

cent. of the total time necessary to complete a joint, the flaring takes fully 5 per cent. of the total time, thus it leaves but about 5 per cent. of the total time to hammer over after the flaring is done. If, however, the complete joint is required, suitable tools are furnished for doing both iron and steel or copper complete, as shown in *Fig. 6*. These tools are also provided with cutters to face off the ends of pipe after it is expanded into the flange if desired.

In addition to these new machines and tools for doing

copper, iron or steel pipe work, we have designed several other machines and tools (*Figs. 7* to *12*) for doing all classes of work, which may be mentioned as follows:

Class "A" machine, for doing iron, steel or copper pipe, from 2 inches to 7½ inches, inclusive.
Class "B" machine, for doing iron, steel or copper pipe, from 8 inches to 16 inches, inclusive.
Class "C" machine, for wrought iron or steel pipe, 16 inches to 24 inches, inclusive.

This latter machine, for wrought iron or steel pipe, has hydraulic forcing attachments for placing the flanges on

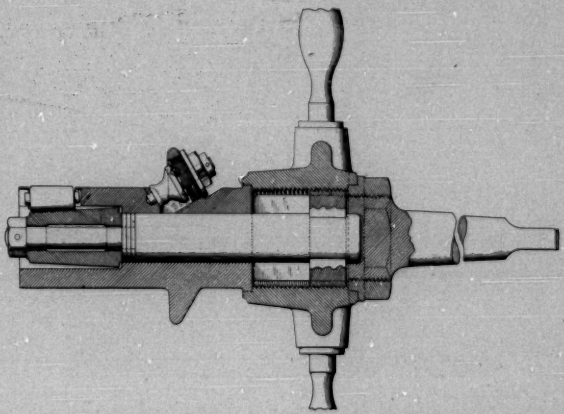

FIG. 8.—Lovekin patent expanding and beading tool for copper pipe only.

pipe prior to expanding, and is also provided with suitable davits on the sides of machine for lifting flanges and tools in place. This machine I believe to be the largest of its kind ever built in the world, and will handle pipe 20 feet long, 24 inches in diameter. The tool itself will weigh 2,200 pounds and the machine will weigh approximately 15 tons.

We have also designed, built and tested:

Boiler tube expanders, as shown, in sizes from 2 inches up to 8 inches. These tools are based on new principles,

and can be used in a pneumatic motor of any of the popular makes, as well as by hand if desired, with less wear than the ordinary boiler tube expander, and with no possibility of breakage of any part. The rollers will outlast all others in use, and the mandrel never wears out, having practically no work to perform. The roller on mandrel will outlast the ordinary expanders, inasmuch as all torsional

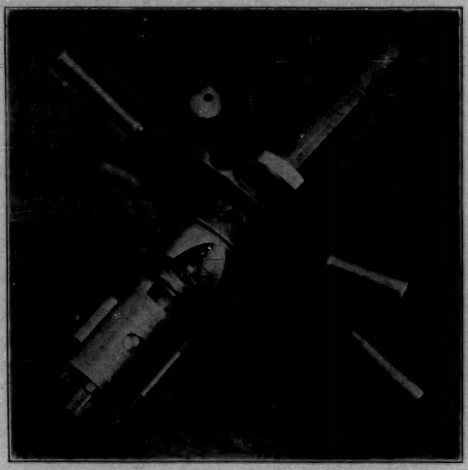

FIG. 9.—Lovekin patent expander and beader for light metal tubes.

strains are removed, and the usual cutting away of the mandrel is not noticed.

In addition, the flaring tools deserve special attention, inasmuch as they are an entirely new product, based on experience, and I believe them to be the best tools ever made for doing such work, with no possible injury to the pipe or tube, such as cracking or splitting at the ends. These tools can be used after expanding the tube, and previous to beading over, in place of hammering, as is usually done. They will save much time and labor and do the work perfectly,

something that cannot be said of the hammering process where tubes are cracked time and again.

VALVE-SEAT EXPANDERS.

These tools are made to work in conjunction with turret lathes, the tool being held fast and the valve revolved on the face plate. The seat is placed in the valve (as shown in *Fig. 11*), and the tool is then forced up until it reaches the face of the seat; this being done, all that is necessary now is to hold the hand wheel which feeds the mandrel

FIG. 10.—Details of Lovekin expander and beader for light metal tubes.

forward, and the small rollers outward, until fully expanded. I believe this method to be far better than screwing seats in valves, and will be found a great help to the makers of large gate valves, as well as other valves.

I made some tests on 2½-inch boiler tubes, samples of which are on the table for inspection with no sign of leakage under 2,700 pounds pressure per square inch, the pipe itself stretched $\frac{1}{32}$ in 9 inches, and I was unable to pull the pipe apart on account of the pressure not being sufficient. I might state that on most tests with ordinary expanders leakage occurs with 1,200 to 2,000 pounds pressure. I believe

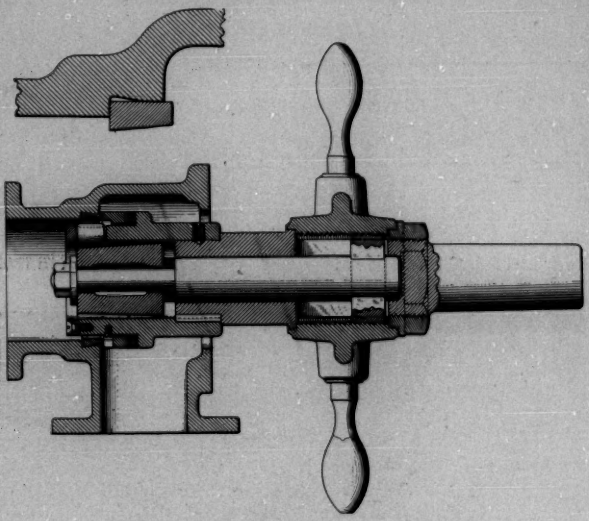

FIG. 11.—Lovekin patent valve seat expander.

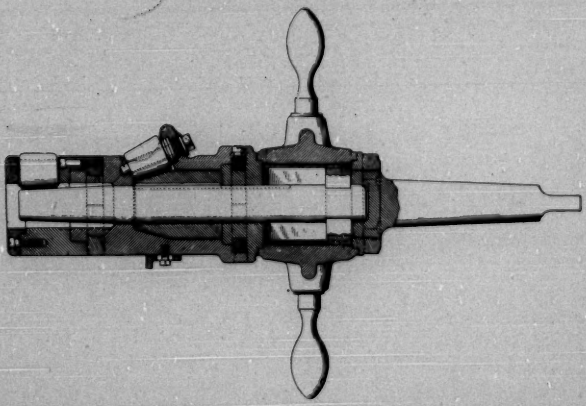

FIG. 12.—Lovekin patent internal driven expander and flarer with cutter.

the joint, as shown by me, would make an excellent boiler tube joint, inasmuch as every tube would become a stay tube.

MEMORANDUM OF PROPER SPEEDS FOR EXPANDING BOILER TUBES; ALSO, COPPER, IRON AND STEEL PIPING.

After experimenting for several years the following speeds are suggested as being the best possible, in order to

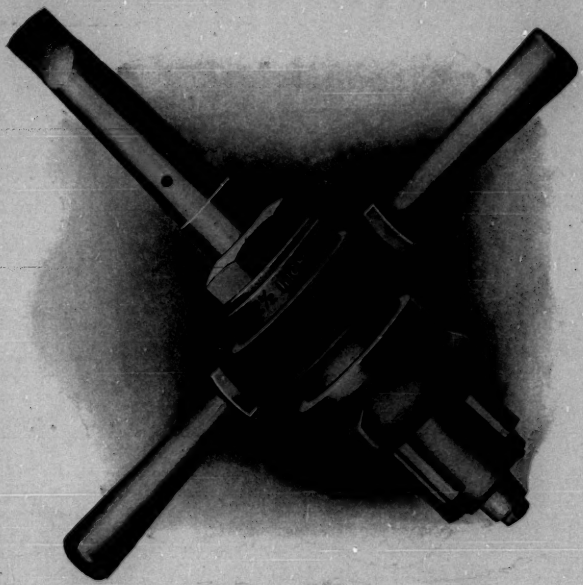

FIG. 13.—Lovekin patent-boiler-tube or flue expander.

insure good, tight work and prevent flaking or scaling of the metal in tubes:

	Max. Speed. Revolutions.	Best Speed. Revolutions.
2-inch Boiler Tube	40	30
2½-inch " "	35	25
3-inch " "	30	20
3½-inch " "	25	17½
4-inch " "	20	15

For other tubes calculate the speed of the tool so as to run at about 15 feet per minute—do not exceed 20 feet. Thus, assuming 8 inches diameter of tube, the circumference is approximately 24 inches or 2 feet, so that we would require to run about $7\frac{1}{2}$ revolutions per minute.

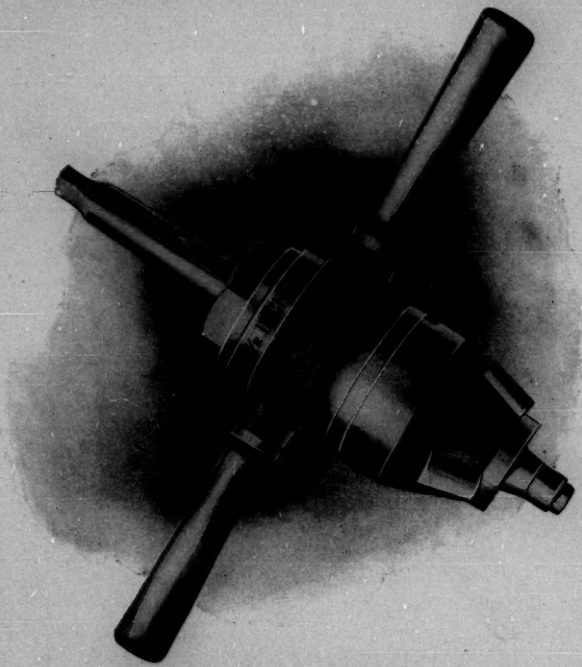

FIG. 14.—Lovekin patent boiler tube flaring or beveling tool.

The following is a description of the boiler tube expanding and flaring tools: These tools can be used in connection with a pneumatic motor of any of the popular makes, and by simply pressing the expander against the tube plate and starting the motor, the expander revolves, the feeding is done by simply holding the handle, while the tool is revolving.

This causes the inner mandrel to come forward, which forces the tapered roller between three or more outwardly expanding rollers. After the tube has been expanded, in order to withdraw same, the handle is turned in the reverse direction, which causes the rollers to collapse (*Figs. 13* and *14*).

The great advantage derived from an expander of this kind is the avoidance of any hammering upon the tapered pin, or any other part of the tool, and the avoidance of any difficulty in expanding or forcing the rollers over lumpy welds. Another important point is that of applying the power at the outside instead of at the taper pin; this facilitates rolling imperfect interior tube surfaces, such as lumps or rough welds, and eliminates the jerking motion so prevalent in the old-style expanders, where lumps are found in the tubes. The rollers are made with proper taper to bring the surface of the rolls parallel with the interior of the tube, thus insuring a good joint throughout the entire tube sheet. The flaring tools are made on the same principle, for doing all classes of flared work (such as the Hartford Boiler Insurance Company require), and I can guarantee these tools to do the work without splitting the tube at the ends. This is also an excellent tool for boilermakers to use after expanding the tube, as it does away with all hammering, and completes the tube ready for beading over with boot-heel tool.

The scope of these expanders can be greater than with any other form, and the diameter of the tube can be any size desired from 2 inches to 24 inches, without changing the principles of expanding. This is not possible with any other class of expanding tool yet offered.

It might be well to state that instead of using the handle for feeding the central roller, a ratchet or spanner may be employed, when desired, for working in close quarters, and the tools can also be worked by hand, similar to the old-style expander, if desired.

CONCLUSION.

At a later date I made up samples of iron, steel and copper piping as shown, and had these tested to destruction in

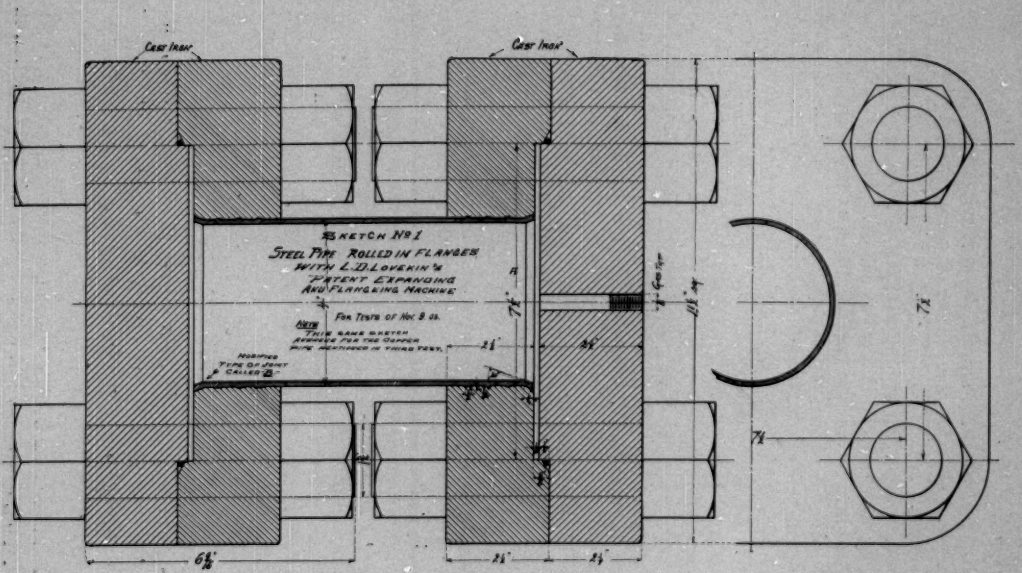
CAST IRON
CAST IRON
SKETCH No 1
STEEL PIPE ROLLED IN FLANGES
WITH L. D. LOVEKIN'S
PATENT EXPANDING
AND FLANGING MACHINE
FOR TESTS OF Nov 8 00.
NOTE
THIS SAME SKETCH
SERVES FOR THE COPPER
PIPE MECHANICS IN THESE TESTS.
NOTICE
TYPE OF JOINT
IS CALLED B
7½"
6½"
2½"
2½"
7½"
7½"

FIG. 15.

nearly all cases to see the effect of pulling flanges off the pipe.

These tests were made at the laboratory of The Quimby Engineering Company, 915 Ridge Avenue, Philadelphia, Pa., whose report follows:

NOVEMBER 11, 1903.

Mr. L. D. Lovekin.

DEAR SIR:—The following is my report on tests of expanded and brazed pipe joints:

On November 9th I started the test on a piece of 4-inch, inside diameter, steel tube No. 10, B.W.G. thick, expanded into cast-iron flanges on each end $2\frac{1}{2}$ inches thick, each end being covered with cast-iron blank flanges $2\frac{1}{4}$ inches, these being held by four $1\frac{3}{4}$-inch bolts, a standard $\frac{1}{8}$ inch gas pipe connection being tapped into one end for applying hydraulic pressure, all being the same as per drawing M, — 1 and M, 2. (*Figs. 15* and *16*.)

On applying pressure up to 2,500 pounds per square inch, a slight weeping was noticed in one of the expanded joints. Below 2,500 it was perfectly tight. This did not seem to increase materially as the pressure increased. On this test we had great trouble with the round rubber used for making the joints. It was of poor quality and blew out. After repeated trials we managed to get 3,200 pounds per square inch with an elongation of about $\frac{1}{32}$ of an inch without any permanent set, showing the elastic limit had not been reached. A second test was made on this specimen after getting new rubber, and a maximum pressure of 3,800 pounds per square inch was attained without any set in the pipe. At this pressure the flanges sprung apart, allowing the packing to break. This occurred on several trials at about the same pressure, showing that the flanged joint would have to be strengthened with additional bolts or clamps for a higher pressure test.

The second test was made on a piece of 4-inch, inside diameter, copper pipe, $\frac{5}{32}$ of an inch thick, each end being hammered and brazed into composition flanges $1\frac{5}{8}$ inches thick, otherwise being the same as test No. 1. *Figs. 17* and *18* show, respectively, the shape, etc., of the specimen

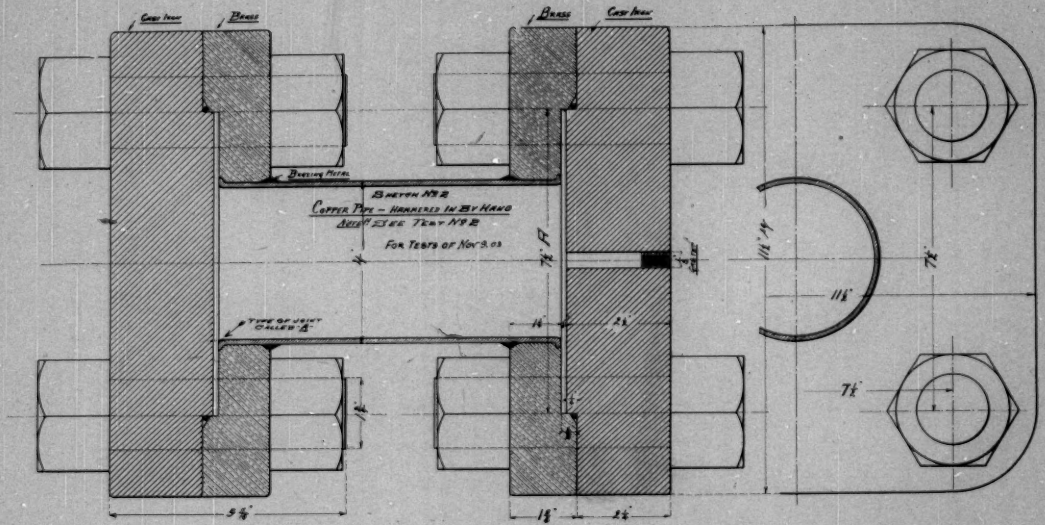
Cast Iron
Brass
Brass
Cast Iron
Bearing Metal
Beton N°2
Copper Pipe — Hammered in By Hand
See Test N°2
For Tests of Nov 3.03
Type of Joint Called "A"
11½"
7½"
7½"
9¾"
1½"
2½"

FIG. 16.

V. 19

before and after the test. This pipe began to elongate at 600 pounds per square inch, with a permanent set of $\frac{1}{32}$ of an inch at 800 pounds per square inch from this pressure until 1,900 pounds per square inch was reached, when the pipe

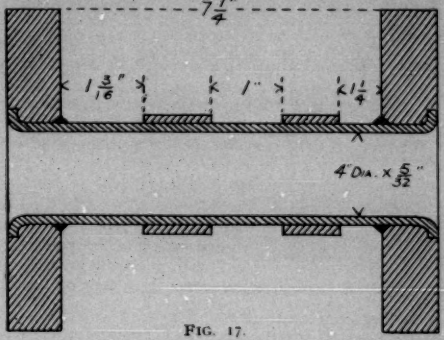

FIG. 17.

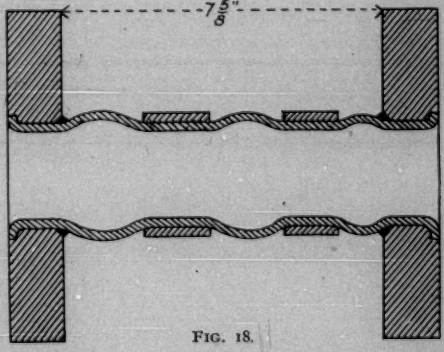

FIG. 18.

burst near one flange, as indicated on *Fig. 18*, at the brazing. The elongation was $\frac{3}{8}$ of an inch, the pipe also bulged considerably in the center from $4\frac{1}{4}$ inches to $4\frac{3}{8}$ inches, and near flanges to $4\frac{7}{16}$ inches in diameter. There is every rea-

son to believe that if the pipe had not burst as it did, that with a small increase in pressure the pipe would have pulled apart. The brazed joint, as far as I could see, was intact.

The third test was made on a piece of 4-inch, inside diameter, copper pipe, $\frac{5}{32}$ of an inch thick, each end expanded into cast-iron flanges $2\frac{1}{2}$ inches thick by your method, otherwise being the same as test No. 1.

At 3,000 pounds per square inch,	elongation was $\frac{1}{32}$ of an inch, no permanent set in length of tube.
" 3,500 " " " "	elongation was $\frac{1}{16}$ of an inch with a permanent set in length of tube.
" 3,800 " " " "	commenced to pull flange off of tube very slow.
" 3,400 " " " "	flange slipped on tube $\frac{5}{16}$ of an inch with a jump.
" 600 " " " "	flange slipped on tube $\frac{5}{32}$ of an inch, pressure dropped to 400 pounds per square inch and, gradually getting less, pushed the flange completely off the tube.

It was noticeable that after the joint slipped $\frac{5}{16}$ of an inch and applying the pressure a second time, there was absolutely no leak.

There were three grooves in the bore of the flanges, $\frac{1}{8}$ of an inch wide by about $\frac{1}{64}$ of an inch deep. These grooves were filled with the copper and sheared off during the 3,800-pound test, but the flaring at the ends was compressed into the hole in the flange and drawn through. The flange on the other end showed that it had also started. The expanding was perfect, as the copper tube shows every tool mark in the boring of the flange; it also shows that the metal had flowed well into the grooves.

The difference between the strength of the pipe brazed and the one not brazed is particularly noticeable, viz:

Using the U. S. Navy formulæ for copper pipe

$$T = \frac{P \times D}{8000} + \frac{1}{16}$$

and solving for P on the above thickness of pipe, viz., $\frac{5}{32}$ of an inch, we have

$$\frac{\frac{3}{32}'' \times 8000}{4''} = 187 \text{ pounds}$$

per square inch working pressure that 4-inch I. D. $\times \frac{5}{32}$ of an inch copper pipe is good for.

In the case of the brazed pipe we have

$$\frac{800 \text{ pounds elastic limit}}{187 \text{ pounds working pressure}} =$$

about 4¼ as the factor of safety up to the elastic limit.

In the case of the expanded pipe we have

$$\frac{3{,}500 \text{ pounds elastic limit}}{187 \text{ pounds working pressure}} =$$

about 18·7 as the factor of safety up to the elastic limit. This shows that the strength of the brazed pipe was lowered 4·4 times below the strength of the expanded joint not annealed.

The total load required to start the flange on the tube was:

A = area outside diameter tube.

P 9 = pressure per square inch on the above area when joint started to slip.

3,800 pounds × 14·6 square inches = 55,480 pounds pull.

$\frac{55{,}480}{2}$ = 27,740 pounds stress per square inch.

Area — $4\frac{5}{16}$ of an inch = 14·6.

" — 4 inches $= \frac{12{\cdot}56}{2{\cdot}04}$ square inches, say, 2 square inches of metal.

The copper was good for about 30,000 ultimate tensile strength.

The pressure used on these tests was hydraulic applied by a screw press, so that the pressure was applied gradually and there was no possibility of sudden shocks or pressures such as would come from a plunger pump. The pressures were read from a Shaw Differential-Plunger Mercury Gage, U. S. Standard, the accuracy of which is well known.

There were forged steel bands applied to each pipe on test, as shown in *Figs. 17* and *18*, to prevent the pipes from bulging and bursting under the excessive pressures required

to pull them apart. These bands were $\frac{3}{8}$ of an inch thick by about $1\frac{3}{4}$ inches wide.

(Signed) QUIMBY ENGINEERING COMPANY,
per W. S. QUIMBY.

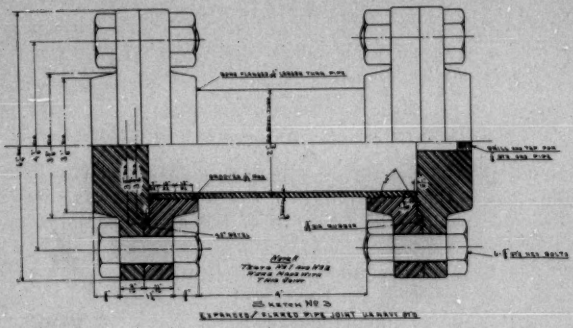

FIG. 19.

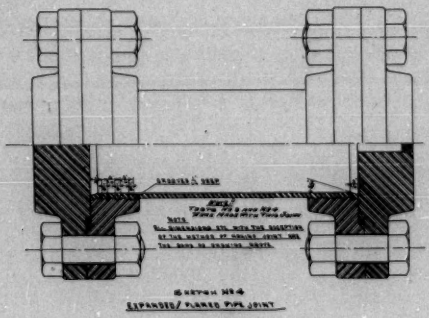

FIG. 20.

I also made several tests on November 18, 1903, at the Quimby Engineering Laboratory, on $2\frac{1}{2}$-inch steel tubing, as made by the Shelby Tube Company, with standard U. S. Navy forged steel flanges, as shown in *Figs. 19* and *20*. These tests were made with a view of ascertaining the

value of a joint, as proposed by me, compared with a joint made in accordance with the U. S. Navy method of rolling the metal over into a recess, as shown. Both of these pipes were rolled into flanges with my expanders, so as to get a fair comparison, the results of which are appended.

According to the reports of the Quimby Engineering Company, all previous tests of tubes rolled into plates have failed under a test pressure of 1,200 to 2,000 pounds. And I can say with certainty that with my tools we can obtain test pressures of fully double that of an ordinary expander.

PHILADELPHIA, November 23, 1893.

Mr. L. D. Lovekin:

The following is the report on tests of expanded pipe joints, made with specimens as per drawing:

Test No. 1.—The tube being expanded into flange by your patent tube expander, was afterward carefully beaded by hand, conforming to the U. S. Navy Standard Rules. Pressure was applied gradually, when pipe began to stretch at 2,600 pounds, and a slight weeping at joint was detected when pressure had reached 4,200 pounds; pressure was then reduced and rubber gasket was renewed.

Pressure was again applied when at 4,650 pounds, pipe stretched $\frac{1}{64}$ inches, showing that it had reached its elastic limit, when one bolt in flange broke. No leak had occurred in joint up until breakage of bolt. After the renewal of same, bolts began to stretch at 5,200 pounds pressure, when a slight weeping again occurred, but joint withstood a pressure of 5,600 pounds, when gasket blew out.

Summary.—During this test, pipe attained a permanent stretch of $\frac{1}{32}$ inches with a lateral bulge at center of $\frac{3}{64}$ inches.

(Signed) QUIMBY ENGINEERING COMPANY,
per W. S. QUIMBY.

PHILADELPHIA, November 23, 1903.

Mr. L. D. Lovekin:

Report of Test No. 2.—Pipe was expanded into flange by your patent tube expander, and beaded by hand, conforming with the U. S. Navy Standard Rules, 1,000 pounds pressure

being applied at start, then the pressure was increased by stages of 200 pounds until reaching 5,000 pounds rubber gasket blew out. After renewal of which pressure was again applied, until upon reaching 5,900 pounds bolts gave out, clearly showing that pressure had been applied beyond bolt section, and that bolts were not sufficiently strong to withstand the test.

Pipe bulged $\frac{1}{16}$ inch at center during test.

(Signed) QUIMBY ENGINEERING COMPANY,
per W. S. QUIMBY.

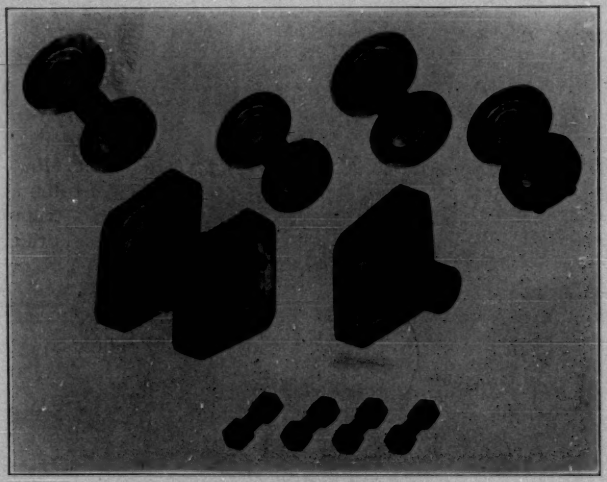

FIG. 21.—Test specimens.

PHILADELPHIA, November 23, 1903.

Mr. L. D. Lovekin:

Tests Nos. 3 and 4 respectively.—Joint was expanded only, and by your method, no beading having been resorted to.

Pressure at start was 1,000 pounds; this was increased by 1,000 pounds increments. Upon reaching 4,900 pounds pipe pulled out of flange nearly $\frac{1}{4}$ inch; pipe also bulged $\frac{1}{32}$ inch at center.

Test No. 4.—Same condition prevailing with regard to joint, as in the preceding test.

A starting pressure of 1000 pounds was applied, and then increased to 2,000 pounds, 2,500 pounds, 3,000 pounds, 3,800 pounds, 4,000 pounds, and then by stages of 200 pounds until having reached a pressure of 5,900 pounds, flange pulled nearly off from pipe, while the pipe bulged $\frac{1}{16}$-inch at center.

The same factor of safety applies to both tests, Nos. 1 and 4, as the pressure applied and attained was the same in both cases.

(Signed) QUIMBY ENGINEERING COMPANY,
per W. S. QUIMBY.

Fig. 21 shows a photograph of several test pieces as exhibited at the meeting.

IMPROVEMENT IN YARN MANUFACTURE.

An invention has recently been made by an English manufacturer which relates to improvements in yarns such as are to be used in the manufacture of textile goods, the object being to construct a serviceable yarn from material which has hitherto been considered of little or no value, or to construct an exceptionally strong yarn at a very cheap rate. The invention consists of a yarn having a core or center thread around or upon which is the body or yarn proper. The core yarn may consist of one or more materials, such as cotton or worsted, or a combination of the two, and the body of cotton or other material, such as silk, wool, shoddy, mungo, flax, waste, or a combination of any of these. According to this invention, the core thread (consisting, say, of cotton) is covered entirely with any other desired fiber (say, of wool), so combining the strength of the core with the utility or appearance of the body. By combining the core and body as described, fibers, such as waste or mungo of such short staple as to be of practically no spinning value, may be utilized in the manufacture of textile goods possessing equal or greater strength and being similar in appearance to goods manufactured from high class fiber. The core and body constituting the improved yarn are combined in the following manner:

The fiber forming the body of the yarn is removed from the swift, or carder, by means of a condenser doffer and card and iron strippers in the ordinary way, and the core thread is brought from any adjacent point to and between the card stripper and the iron stripper, from which point the two together pass between the rubbers and the body is rubbed around the core sufficiently to keep the two together when on the condenser bobbin, from which the yarn is spun in the ordinary manner.—*Scientific American Supplement.*

RADIUM IN MINERAL WATERS.

As bearing on the distribution of radium in nature, some results obtained by R. J. Strutt and given by him in a paper read before the Royal Society, March 10, 1904, are of interest. Mr. Strutt found that deposits from two hot springs at Bath and one at Buxton, England, showed radio-activity. The rate of decay of emanation from the deposits was found to be identical with that of the emanation from radium, and there is every reason to believe in the presence of radium. The quantity present of this element is, however, very small, the total amount contained in the water discharged by the Bath spring during a year being estimated at ⅓ of a gram. The spring gives off about 100 cubic feet of gas per day, about 0·1 per cent. of which is helium, so that about 1,000 liters of helium are given off annually. The proportion of helium to radium, though somewhat larger than in the radio-active minerals, is in accordance with the view that the spring draws its supply from the disintegration of such minerals.—*Engineering and Mining Journal.*

EFFICIENCY OF MODERN DISTILLING APPARATUS.

The combustion of 1 pound of coal in a well-designed boiler furnace will evaporate from 8 to 10 pounds of water, which is considered a fair commercial rating. But in the purification of bad water or sea water by distillation the fuel cost of the direct process is practically prohibitive. By using distillers built on the so-called Yaryan multiple-effect system it is possible and practicable, however, to more than quadruple the evaporative power of a pound of coal, or rather to more than quadruple the product of distilled water. The steam from the main boiler is led into what to all purposes is another boiler, and by its condensation it evaporates the water containing impurities, the steam from which passes into another so-called boiler and repeats the operation. The result is that each drum acts both as an evaporator and as a condenser. The successive evaporations are made possible by maintaining a successively decreased pressure in each boiler. A Scottish firm, Mirrlees, Watson & Co., Glasgow, recently built two sextuple-effect distillers for the Egyptian Government which yield about 45 pounds of distilled water for each pound of coal. Each plant consists of six horizontal cylinders arranged vertically, one over the other, the total height being something like 39 feet. The pressure in each shell is graduated, being less in each successive effect than in the preceding one, which makes it possible to boil the water in one by absorbing the heat of the steam in the preceding effect. The apparatus, of course, includes steam pumps for maintaining the circulation.—*Machinery.*

CRYOSTASE.

A curiosity of the physico-chemical domain is cryostase, a mixture of equal parts of phenol, saponin, camphor, and a little turpentine oil. This body possesses the astonishing property of liquefying in cooling and solidifying on being heated. True, albuminoids also have this peculiarity, but in distinction from these, the process can be repeated any number of times with cryostase. Solidified albumen cannot be liquefied again by means of cold.—*Deutsche Medizin Zeitung.*

Mechanical and Engineering Section.

Stated Meeting, held Thursday, March 24, 1904.

The Execution of Architectural Design.

By John McArthur Harris, M.A.,
Member of the American Institute of Architects.

When your Secretary asked me to speak to you I told him I would take for my subject "The Execution of Design," and he suggested that I should add the word "Architectural," making the subject "The Execution of Architectural Design." I accepted this because I felt that the limitation was a good one, although the subject might be misunderstood.

The expression Architectural Design is used generally and quite properly as describing an illustration of some specific thing or idea developed by an architect. I might, for example, refer to a drawing of a bank and say, "that is my design for a bank," but this is not the meaning I wish to give the expression here to-night.

The meaning may perhaps be conveyed more clearly if we say "purpose" instead of "design," and expand the title to read "The Carrying Out of Architectural Purpose."

An architectural design must be the work of a man who is actually, in so far as the design goes, an architect, even though he may not be an architect by profession. Architectural design or purpose may be conceived by any one, and is, in fact, generally conceived by some one who is not an architect.

It is well that this should be understood clearly. The original design, purpose, concept, or whatever we are to call it, is not the architect's. When a client goes to an architect he goes with a purpose or design in mind which he wishes to have executed, and it is about the execution of this design that I will speak to-night—about the parties who execute it and the instruments that are used to unite these parties in their undertaking.

There are two divisions of this subject—two periods of execution:

First. The period of expression.

Second. The period of action.

In the first period the parties interested are the owner, the architect and contractors.

The instruments of service are:

(1) The drawings.
(2) The specifications.
(3) *a.* The invitation to bidders.
b. The advertisement and supplement.
(4) The proposal.
(5) The acceptance.
(6) The contract.

In the second period the parties interested are the owner, the architect and the contractor.

The instruments of service are:

(1) The signed contract.
(2) The bond with its collateral (fire insurance).
(3) Architect's certificate.
(4) Release of liens, etc.
(5) Guarantees.

It will be noticed at once that in both periods the parties interested are called by practically the same names, but their functions are widely different. In the first period we have the owner, architect and contractor—that is, the conceiver of the purpose, the expresser of it, and the price-namer. In the second period we have again the owner, architect and contractor; but now they are the paymaster, the inspector and arbitrator in one, and the builder.

The first period is that which ends with the preparation of the contract and is taken by the owner or party whose purpose or design is to be executed with the assistance of the architect to express for him this design, and by a third party—which may be one or more contractors—who names a price for which the design can be executed, and who signifies his willingness to enter into a contract to execute it for the price he has named.

The second period commences with the signing of the

contract and is taken by the contractor with the assistance of the owner, who furnishes the money, and of the architect, who fills the position of superintendent of the work and arbitrator of disputes between the contractor and owner, about matters subject to his judgment or opinion.

It simplifies very much the first period, if all three parties remember that its end is the drawing up of an efficient contract.

As that contract is to express the owner's purpose, that purpose must be defined clearly or it cannot be expressed successfully.

As an illustration of this I may cite the problem of the dwelling house. This is one of the most difficult problems because each room should fit the need or purposed use of the occupant, and special needs cannot be foreseen unless expressed; so that an owner who knows only what rooms he wants and how much he can pay, cannot get the same sympathetic house as the owner who has clearly defined the life which his house must environ.

An architect may develop a house with the knowledge of what beautiful home-life ought to be, and this house may be a successful educator; but no house is so near the ideal as that which has been developed to fit the clearly defined ideas of the man who lives a beautiful life therein.

The architect may develop a house—the owner makes the home. Unless the house expresses the home-life, the highest purpose has not been reached. This truth applies to all the petty details of the problem. If the owner will have two servants or three; if he blacks his own boots; if he has many or few books; if he is fond of flowers—all these are things that he should know about himself, and knowing them, he should see that his house meets the needs of its master with the fullest opportunity he can command.

The architect, too, must remember that the end of this first period is the drawing up of an efficient contract. What are the drawings for? What are the specifications for? Why are bids asked and schedules prepared?

No matter how much he may enjoy the work, no matter how beautiful any of his drawings may be, he must face the

practical fact, that none of his productions are of value to the party for whom they are made except as they rightly express in the contract the purpose of that party.

As for the contractor, it is only necessary to state the proposition and hardly that. The difference in result is wide when a contractor estimates the value and bids to execute what he considers the purpose of the owner so that a fair value or price may be stated in the contract, and when he bids with the purpose of taking advantage of an inadequate expression of this purpose.

I shall refer again to the contractor and state the problem of his selection. This problem has not, to my mind, been satisfactorily solved.

Let us now look at the instruments that unite the three parties in the first period of the execution of architectural design—in the period of expression.

(1) THE DRAWINGS.

The first instrument developed is, of the necessities of the case, the drawings. The reason for this is apparent. As the drawings are a graphical projection, so to speak, of the purpose to be executed, and as they afford the only practical and adequate method of projecting in more than one mind the same ideas of this purpose, it is necessary that this projection should be made before the other instruments are drawn up.

The error of making estimates on general descriptions, no matter how carefully these may be worded, leads to the reduction of the standard of the practice.

The owner must say first what he wants and how much he is willing to pay for it. If he is not willing to say what he will pay for his building he should incur, without question, the expense of having what he wants drawn out sufficiently to enable an estimator to do something more than guess, in order to determine the scale on which his purpose is to be projected.

This is only one illustration of many that might be given of the importance of expressing by drawings the possibility of the problem before elaboration in other directions.

With reference to the drawings themselves, either how to make them express beautiful things or how to do this with beautiful draughtsmanship, I cannot speak to-night. I must say in passing that I believe it is an architect's first duty to express beautiful ideas and to give, where possible, to his clients the desire, if they do not possess it, of the beautiful. I must say also that I think it is well worth while to make beautiful drawings in spite of the fact that the finished product of an architect is not the drawings but the building.

The drawings should, however, as instruments forming part of the contract, be exact, and in order that they may be so a few rules are necessary:

(1) Nothing should be drawn in elevation without drawing it in section and plan, unless section and plan are so familiar that they can be clearly projected in mind without putting them on paper.

(2) The finished product is the building, and not the drawings, and nothing should be put on the drawings that does not have value to the estimator or builder, simply for the purpose of making a drawing pretty.

No sketching should be done on a working drawing. Texture, shadows, etc., may be shown, but they must be accurate and to scale.

(3) The question must be constantly asked, Do I know what is meant by this, and will somebody else understand it?

When the question arises, what things should be left for the specification, the answer to it can only be given in a general way. It is better to mark specific and exceptional cases on the drawings, as, for example: If a small roof over a part of a building not easy to identify by written description, is of sheet metal, and the rest is to be roofed with slate, it is wise to mark on the drawings the fact that this roof is covered with sheet metal. It is also better to leave for the specification the general statement that the roofs of the building are covered with slate, except in the case of the roof otherwise marked on the drawings. Apart from this general rule, questions answer themselves as they arise.

Certain details are much easier to show by drawings than

they are to describe by writing, and *vice versa*, and, keeping in view the essential of clearness, it may be said that where two methods are equally clear, the easiest method of description is the best; but it is the experience of most architects that unless the work is fully drawn out, it is not safe to depend upon the memory to suggest the things that are to be described.

(2) SPECIFICATIONS.

As it is not practically possible to describe thoroughly everything on the drawings, it is necessary to supplement these with a written description, which must cover not only the work to be done, but the conditions under which it is to be done, and this description is called the specification.

It is worth while at this point to note that the drawings and specification must pass into the hands of every one interested in the work, and, it may be, that certain conditions are of such a confidential nature, between the owner and the contractor, that it is not wise to spread them before the sub-contractors, mechanics on the building and others who may, through curiosity or necessity, examine them. Such matters are, the time of the completion of the work, the bond given by the general contractor to the owner, and other confidential points that may arise.

It often happens that the general contractor, as a matter of business precaution, requires his sub-contractors to finish the work they have to do for him long before he is required to finish the whole building, and to furnish greater security in proportion to the amount of work than that required of the general contractor by the owner. The general contractor, therefore, should not be handicapped by having such obligations as these put in the specification. They should be put in the contract proper; but, in order that he may know what he has to bid on, the amount of the bond, and the date of the completion of the work, if it is fixed at the time the invitations are sent out, should be stated in the invitation to the contractor when he is asked to bid. The specification states the business relations between the owner and the contractor, in as far as they relate to the method of carrying out the work, and should set forth

clearly how the work is to be superintended, and it should give, in a sort of preface, a general statement of the work to be undertaken, that the specification may be read intelligently from the beginning of the description.

We have now reached a part of this theme that has been with me so constant an object of thought for many years that I would like to enlarge upon it and perhaps give it undue prominence in this evening's work. I refer to the methods of the specification writer—to the difficulties of the work, and the great importance of the specifications as part of the contract.

The law of specification in philosopher's terms is this: "No matter how far specification is carried it can always be carried beyond."

This is the law under which the ancestor hunters seek their elusive game. Every ancestor they find justifies the belief that there are at least two more. And the genealogist after all is only writing the specification which, as it reaches back to ancient times, more and more fully describes the sources of our blood.

All specifications start with a statement that the work is to be complete, and all beyond is an amplification of this word complete.

Wherever there is more than one way to complete the structure the specification writer must know it and he must remember it. He must know also the best way and he must clearly describe it. His knowledge of the best way comes from education and experience, and these are both long stories. He can aid his memory by notes and, best of all, by method—by pursuing some regular order in writing.

As an illustration of this I think we can readily see that it is less difficult to remember the items of hardware if we specify all the hardware for doors first and then all for windows, and under the head of doors if we specify all the locks first and then all the hinges, etc., etc., than if we tried to mention these items without regular order. But it is sometimes hard to find the thread that will lead us through this maze, and, having found it, it is hard to stick to it; but I believe success lies only along this path.

The drawings and specifications together constitute the owner's statement of his requirements expressed by the architect.

(3*a*) THE INVITATION.

A formal invitation for bids usually states where information can be obtained—the time and place for the delivering of the bids and conditions of a more or less confidential nature that can not be put in the specifications, such as the amount of the security required.

(3*b*) ADVERTISEMENT AND SUPPLEMENT.

In the case of public work the laws generally require that the widest latitude be given in selecting bidders, so that the invitation usually takes the form of an advertisement in the public press. Advertisements of this sort are usually brief and often state no more than that information can be had at such a place with reference to work on which the City or Government requests bids. The work is described in general terms. For the information of parties making inquiry at the place named, a supplement which contains a schedule to be filled by bidders is prepared and given out so that inquirers, who are often only messengers, may have a pretty good general idea of what is to be bid on before taking a set of drawings and specifications which are too valuable to be distributed carelessly.

(4) THE PROPOSAL AND (5) THE ACCEPTANCE.

The proposal is a statement of the amount for which the maker will undertake to execute the design expressed by the drawings and specifications, and the acceptance is simply a statement by the owner that he accepts the proposal.

The more simple the proposal and acceptance are the stronger they are.

Two or three facts which I can give you on the authority of "Engineering Contracts and Specifications," by J. B. Johnson, C.E., Dean of the College of Mechanics and Engineering, University of Wisconsin, will show at once what important instruments the proposal and acceptance are.

In order that the contract shall be binding on both par-

ties to the agreement it must have been understood and assented to by both in the same sense.

This agreement is not consummated until each party has communicated his intention in the matter.

The person who makes an offer must allow a reasonable time for its acceptance and if the acceptance is returned by the same agency used in sending the offer, the contract is completed at the time the acceptance is delivered to this agent. For example, a proposition sent by mail is accepted at the time the letter of acceptance is deposited in the post-office or letter-box, and a proposition sent by telegraph is accepted at the time of delivery of a telegraph reply at the telegraph office or to a telegraph messenger.

When an offer is made by mail or telegraph these agents become the recognized agents of the party making the offer and that party is bound by their mistakes.

It is customary to state, in asking for bids for executing architectural design, that the owner reserves the right to reject any or all propositions.

The formation of a contract really dates from the transmission of the acceptance.

The formal contract is a recitation in brief of obligations undertaken by the contractor and owner and it should be as brief as it is possible to make it. The advantage of having these obligations on one paper signed by both parties—sealed and witnessed—is that it renders easy in case of dispute the proof of mutual assent, and avoids the necessity of proving that one party did accept the proposal of the other in a binding manner.

The drawing up of this contract completes the first period of the execution of architectural design.

With the signing of the contract the contractor becomes actually the most important party in the transaction. If the first period has witnessed that harmony and intelligence of action that (as I have stated) alone make for success, and if the contractor fulfils all his obligations, he alone is active; but as conditions are rarely so ideal, both owner and architect, as a rule, are fully occupied on the one hand in amplifying the expression of purpose, and on the other in

demanding the fulfilment of obligation. The fact remains, and it is a most important one, that the contractor is the one party through whom all the work is done. The finished building is the goal of the architect's efforts and of the owner's purpose. The owner pays for it, and rightly or wrongly the architect must take the moral responsibility for it, and yet after the contract is signed and until it is completed or annulled the contractor controls the destinies of the work.

I wish to emphasize this fact because it will help to make clear the statement of my problem of the selection of the contractor. As long as the latter remains a party to the contract, as the active worker, he dominates it either for good or ill. Even if he neglects it, his neglect becomes the dominant fact.

Because the contractor may be incompetent financially, or in some other way, it is customary to require security for the faithful performance of the contract. Asking this security is so customary a matter of business that it conveys no moral reflection or aspersion of character. This was not always the case. It was a matter of great pride with some of the older men fifteen or twenty years ago that they never gave bond. But the financial magnitude of architectural undertakings has made more general the practice of asking more than one party to unite to carry the financial responsibility, and since the first requisite of a good bondsman is that his value should be permanent, it is customary to find corporations acting in this capacity.

While the bondsman and the contractor unite in this way to protect the owner from loss, the owner becomes obligated to advise the bondsman of any change contemplated in the contract, and it is well for the owner to have the expressed satisfaction of the bondsman before making changes, or the latter may slip his obligations.

It is, of course, the practice to have the bond executed before any money is paid to the contractor, but it is better practice to demand the execution of the bond immediately after the execution of contract.

[*To be concluded.*]

Notes and Comments.

THE END OF THE MORRIS CANAL.

The famous Morris Canal in New Jersey is practically condemned in a report just rendered to Governor Murphy by ex-Governors Werts, Griggs, and Voorhees. The canal company was incorporated in 1824 and built this waterway soon afterward, from Phillipsburg on the Delaware River to Jersey City, a distance of 106 miles. A number of reservoirs were constructed, some of which are now summer resorts and surrounded by valuable estates. The State has a right to take the canal in 1974. It was leased in 1871 to the Lehigh Valley Railroad Company, which has since operated it. The eminent commissioners report that even were the property in perfect condition, it could not be operated at a profit. The decline in its value has been due to the construction of railways which became powerful competitors, carrying freight at cheaper rates than is possible with the canal boats except at a loss. Eventually all traffic was diverted from it except the trifling amount from the lessee. At the present time it stands in the way of needed public improvements, but its abandonment involves the untangling of a complication of interests, including the stockholders of the canal company, the lessor railroad company, the State, the municipalities along the route, the landholders about the reservoirs, and the people having contracts for important water rights, not to mention a lot of trifling claimants for consideration. While the abandonment is assured, it now appears that it will involve more trouble and delay than the original construction of this canal, once the pride of northern New Jersey.—*Engineering Record.*

TIN IN ALASKA.

From a valuable Bulletin lately issued by the U. S. Geological Survey we reproduce the following conclusions:

"The above facts show cassiterite to be rather irregularly distributed through an area of about 450 square miles, embracing the western end of Seward Peninsula. At three localities—Anikovik River, Buhner Creek and Buck Creek—its occurrence in placers has been verified by the Geological Survey, and lode tin has been found by the Survey at Lost River and at Cape Mountain. There are a number of other places where prospectors report its occurrence in lode or placer form. The tin ore is almost all cassiterite, though a little stannite has been found at one locality. Its original source is in deposits of at least two essentially different types. In the one it is in quartz veins, which cut phyllites or metamorphic slates; in the other the cassiterite is disseminated through more or less altered granitic rocks. This second type of lode deposit is the one which gives promise of commercial importance.

"In estimating the value of tin ores in this northern region several facts should be borne in mind. The region is utterly without timber, and is accessible by ocean steamers only from June to the end of October at the longest. Harbor facilities are poor, and all supplies and wages are high. On the other

hand, the construction of railroads and wagon roads is not difficult, and will require comparatively small outlay. All of the occurrences described are within a few miles of tidewater. Freight rates to Puget Sound ports should be very low, as the large fleet of ocean steamers which runs to Nome returns empty. Last summer upward of 98,000 tons of freight were brought to Alaska by vessels that called at Nome. It is fair to say that these tin deposits are well worth careful and systematic prospecting."

ELECTRICITY DIRECT FROM COAL.

R. Lorenz gives a capital summary of the present state of the problem of directly converting the chemical energy of burning carbon into electricity. The slow combustion involved in an electrolytic process such as is exemplified in an ordinary voltaic cell suffers under three disadvantages—viz., the slowness of the reaction between C and O at ordinary temperatures, the impurity of the carbon, which gives rise to complicated hydrocarbons in solution, and the necessity of using the highly-priced conducting forms of carbon instead of ordinary coal. These circumstances led to the adoption of a gaseous "electrode" consisting of carbon monoxide, as in the cells of Bucherer and Borchers. In these, however, the currents obtained cannot be proved to result from the further oxidation of the CO. Indeed, the existence of CO ions has yet to be demonstrated. Another and more indirect way of utilizing the energy of carbon is that suggested by Nernst, in which carbon is used for regenerating other cells, such as Daniell's cell, by the reduction of the zinc sulphate. Another method proposed by Nernst is to heat an accumulator having a negative temperature coefficient until its E.M.F. disappears and then let it cool. Dolezalek has, indeed, obtained an E.M.F. of 0·6 volt between two lead accumulators having a difference of temperature of 90°. The problem is theoretically soluble, but will require much detailed work for its final solution.—*R. Lorenz, Mitt. Phys. Ges. Zürich, No. 5, 1903.*

USES OF GILSONITE AND ELATERITE.

The uses to which gilsonite and elaterite are put are varied. There is a big shortage in the world's supply of vegetable rubber, and these hydrocarbons are now taking its place. They are made into a mineral rubber that unites perfectly with tree rubber, thus permitting a very large reduction in the amount of the latter used, and cheapening its cost materially. Second-grade gilsonite is used for paving cement by melting it with petroleum residue and mixing it with ground asphaltic limestone and the requisite amount of sand. Gilsonite is also manufactured into varnishes, lacquers, waterproof paint for gun carriages, and steel and wood work of every description known to ship building; as a paint for ship bottoms, it prevents barnacles from attaching themselves. It is also used for pipe coatings, reservoir coatings, floorings, roofings, and railroad work. The following is a further list of some of its uses: For coating barbed-wire fencing; coating sea walls of brick and masonry; coating paving brick; acid-proof lining for chemical tanks; roofing pitch; insulating electric wires; smokestack paint; coating poles, posts, and

ties; lubricant for heavy machines; covering wood-block paving; binding pitch for carbon in making coal briquettes.

Elaterite is being largely used now to make flexible and heatproof varnish and paints, which are excellent for coating shaft and tunnel timbers, for painting hemp and wire hoisting ropes, pump columns, pipes, chains, ore cars, and all steel and iron work where the surfaces are exposed; also for coating vats, tanks, and pan covers used in chlorination works, smelters, and refineries, and in the cyanide process. On ironwork it prevents corrosion and resists great heats. On woodwork it prevents absorption, and defies the elements.—*Mines and Minerals.*

TURBINE OCEAN STEAMERS.

Although the construction of the great turbine-propelled liners for the Cunard Company overshadows in public interest every other marine turbine development just now, it is a fact that there will be some splendid specimens of turbine ocean liners in service on the high seas long before the Cunard vessels are in the water. Mention should be made incidentally of the "Turbinia," which was launched not very long ago in Great Britain, and will soon cross the Atlantic for service on Lake Ontario. Before many weeks a large ocean steamer, the "Tasmania," will be dispatched to Australia, and the Allan Line will place two turbine-driven liners in the Atlantic service of the company. Next year, moreover, a turbine-driven Cunard steamer of about half the tonnage of the 25-knot 40,000-ton turbine ships will be plying between Liverpool and the United States. Considering that the practical turbine is but a decade and a half old, this must be considered a remarkably rapid development of what is commercially considered an entirely new type of steam engine.—*Scientific American.*

URANIUM.

Uranium is one of the rare metals for which there is a limited demand. The present world's consumption amounts annually to about 300 tons of uranium ore, yielding from 3 to 13 per cent. of the metal. For several years Colorado has supplied the United States output, nearly all of which goes to Europe. France, England, and Germany are the principal markets. Uranium is a hard, very heavy (9·184), moderately malleable metal; it resembles nickel and iron, and has the color of nickel. At ordinary temperatures it is not affected by air or water; at red-heat, however, the surface oxidizes. The chief ore of uranium is the oxide, called pitchblende or uranium. It occurs also as the phosphate and arsenate. The ores are found in Gilpin and other counties of Colorado; in Cornwall, England; and in Saxony, Germany. Buyers of the ore generally pay from $15 to $20 per unit, according to the percentage of uranium contained. Until recently uranium salts were used chiefly as a pigment in painting on porcelain, in photography, and as a coloring ingredient in glass manufacture. It is now being used experimentally in the manufacture of alloys of iron and aluminum. Uranium increases the hardness and elasticity of steel, and also the hardness of aluminum, but this use has not yet become sufficiently important to cause an increased demand for the metal.—*Engineering and Mining Journal.*

hand, the construction of railroads and wagon roads is not difficult, and will require comparatively small outlay. All of the occurrences described are within a few miles of tidewater. Freight rates to Puget Sound ports should be very low, as the large fleet of ocean steamers which runs to Nome returns empty. Last summer upward of 98,000 tons of freight were brought to Alaska by vessels that called at Nome. It is fair to say that these tin deposits are well worth careful and systematic prospecting."

ELECTRICITY DIRECT FROM COAL.

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Book Notices.

Electric Traction. A practical handbook on the application of electricity as a locomotive power. By John Hall Rider, Chief Electrical Engineer, London County Council Tramways, M. Inst. C. E., etc. With 194 illustrations. (8vo, pp. xvi + 453.) London and New York: Whittaker & Co.

This volume forms one of the "Specialists' Series," a useful series of handbooks for engineers, issued from the publishers' press.

It is designed to supply the operative engineer with such information respecting the general underlying principles, the construction, equipment and operation of electric railways, as will be likely to prove directly serviceable in his everyday practice. The American specialist will doubtless find it useful as a source of data for comparison with American practice. The work is excellently printed and illustrated and elaborately indexed. W.

Elements of Geology. A text-book for colleges and for the general reader. By Joseph Le Conte, author of "Religion and Science," etc. Revised and partly re-written by Herman Le Roy Fairchild, Professor of Geology in the University of Rochester. Fifth edition, revised and enlarged, with new plates and illustrations. New York: Appleton & Co. 1903. (Price, $4.00.)

It is no easy task to take from the hand of the deceased author one of the four most celebrated text-books on geology in the English language and revise and bring it up to date without allowing the patches to be seen, yet Professor Fairchild, the widely celebrated Secretary of the Geological Society of America, has accomplished it. It might be supposed that so enthusiastic a convert to the new earth chapter of the Nebular Theory of Professor Chamberlin, would inject a great deal of this view into the text, but the only place in which direct reference to the new hypothesis is made occurs on page 295 in two paragraphs on Pregeologic Eras.

The book is well printed on fairly good paper and the illustrations are apt and clear, though some of the older cuts appear to have been "thrown up" from a previous impression. It would have been more in conformity with modern tendency to spell "Archæan" and "Palæozoic," "Archean" and "Paleozoic," or, if the reviser preferred to retain the diphthongs in these words, to have dealt likewise with Cenozoic, which is entitled to the Greek ai in Kainos (new), as much as Archaios (ancient) and Palaios (old).

F.

United States Magnetic Declination and Isogonic Charts for 1902, etc. By L. A. Bauer, Chief of Division of Terrestrial Magnetism. Government Printing Office, Washington, D. C. 1902.

Since the observation of terrestrial magnetism was made a fundamental part of the work of the U. S. Coast and Geodetic Survey in 1855, isogonic charts (those showing the course over the earth's surface of lines of equal magnetic deflection (declination) east or west from the true north) have been published for the following epochs: 1850, 1860, 1870, 1875, 1885, 1890, and 1900 (the last published in 1897). No official publication in this or any other country has exceeded these publications in originality, accuracy, and patient

mathematical computation. The present volume surpasses all the others in detail as in size. It is preceded by a very interesting chapter on the principal facts relating to the earth's magnetism, in which a complete but succinct history of the discovery of all the phenomena observable in the lodestone and magnetized needle, the invention of the compass and its improvement, and the reproduction of the earlier and some of the later isogonic charts from Hansteen for 1600 and 1800, Halley for 1700, and the British Admiralty for 1858 and 1905. The book is filled with descriptions of the magnetic stations by States and tables of observations, and well illustrated by half-tones of the former and of the instruments of the past and present. F.

Franklin Institute.

[*Proceedings of the stated meeting, held Wednesday, June 15, 1904.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, June 15, 1904.

PRESIDENT JOHN BIRKINBINE in the chair.

Present, 145 members and visitors.

Additions to membership since last report, 13.

Rear-Admiral Geo. W. Melville, U. S. N., was introduced by the President and read the paper of the evening on "The Naval Strength of the United States."

The President expressed the thanks of the meeting to the speaker.

Mr. Julian Florian, of New York, gave a brief description of "The Cellutype," an improved apparatus and process for the production—automatically—of positive photographs. The inventors are Messrs. Julius Gregory and Julian Florian. The speaker illustrated the subject of his remarks by a number of practical demonstrations with the machine.

Adjourned.

WM. H. WAHL,
Secretary.

Committee on Science and the Arts.

(*Abstract of the proceedings of the stated meeting, held Wednesday, June 1, 1904.*)

PROF. LEWIS M. HAUPT in the chair.

The following reports were adopted:

(No. 2320) *Tent Fastening.* James J. Rinn, Philadelphia.

ABSTRACT: The invention consists in the use of rigid strips fitted with a simple form of catch to hold them securely together for the purpose of fastening entrances to tents. The device was shown in model for use both on the ordinary round (or bell) tent and on the wall or A tent.

The invention is secured by letters-patent of the United States Nos. 528,391, 2, 3, and 4, under date of October 30, 1894, granted to applicant.

The device can be applied to any tent without requiring any expensive changes or additions to the structure, and commends itself as one admirably adapted to add to the ease and comfort of tent-life.

The closing of the entrance to a tent is often very troublesome in windy or wet weather, and egress and ingress is often a serious inconvenience. With this device the tent can be left and entered practically as easily as through a regular door, and, in addition, the device appears a ready means of leaving the whole front of the tent open, with no loose parts to flap about and gradually shake fastenings loose.

The opinion is expressed that the device has merit and utility, but in view of the fact that it has not yet been applied in practice and tested, the committee recommends the award at this time of a Certificate of Merit. (*Sub-Committee*, T. Carpenter Smith, Chairman; W. W. Canby, C. E. Ronaldson, James E. Rogers.)

(No. 2323.) *Methods and Apparatus for Detecting Corrosion of Metals by Electrolysis.* Adolphus A. Knudson, New York. An advisory report.

(No. 2328.) *Coal Storage Structure.* James M. Dodge, Philadelphia.

ABSTRACT: This invention is protected by U. S. letters-patent No. 539,250, May 14, 1895, granted to Mr. Dodge. Its object is to so construct bins (for storing coal or analogous materials in large quantities) that, although they be built of comparatively light materials, will be so formed and braced as easily to withstand the pressure of the material piled within them. (Not adapted for intelligible abstraction except by means of illustrations.)

In recognition of the originality and simplicity of the mechanical methods employed by the inventor, and the demonstrated utility of the invention as an economical and efficient substitute for the ordinary methods of storage, the report recommends the award to the inventor of the John Scott Legacy Premium and Medal. (*Sub-Committee*, Chas. E. Ronaldson, James Christie, John M. Hartman.)

(No. 2326.) *Feed-Water Regulator.* Amos E. Burrows, York, Pa.

Passed second reading, discussed, and referred back to sub-committee.

The following passed first reading:

(No. 2281.) *Reducing the Attenuation of Electrical Waves.* Michael A. Pupin, New York.

(No. 2307.) *Automatic Electric Semaphore Signal.* J. William Lattig, Wyncote, Pa.

Referred back to sub-committee for information.

(No. 2309.) *Automatic Electric Safety-Block and Train-Control System.* Dr. Samuel D. Strohm, Philadelphia.

(A report of progress.)

(No. 2316.) *Reconstructed Milk.* C. H. and P. T. Campbell, Jersey City, N. J.

(No. 2321.) *Alumino-Thermics.* Dr. Hans Goldschmidt, Essen, Germany.

(No. 2186.) *Tangential Water-Wheel.* Wm. A. Doble, San Francisco, Cal.

Notice is given of a motion to reconsider the report.

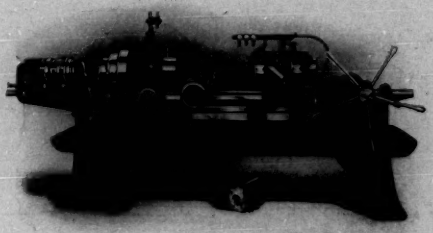
Dr. W. J. Williams, a newly-elected member (*vice* Dr. H. Leffmann, resigned), is presented to the Chair and takes his place in the meeting.

W.

Improved Machinery, Apparatus and Processes.

[This department will contain from month to month descriptions of new machines, apparatus and processes. The data, for which the editor must depend largely on information derived from interested sources, will be carefully edited. The Committee disclaims responsibility.—THE COMMITTEE ON PUBLICATIONS.]

The Pratt & Whitney 3 x 36-inch turret lathe, illustrated by accompanying engraving, will take rod work up to 3 inches in diameter and 36 inches long, and may be provided with chucks for short work of larger diameter. The chuck is arranged to handle stock $\frac{5}{32}$ of an inch oversize to $\frac{1}{32}$ of an inch undersize. This is accomplished by means of two levers, one which brings the chuck-jaws in contact with the stock and the other which clamps them on the stock, insuring a uniform clamping pressure. The power-rod feed mechanism has no delicate parts to get out of adjustment or mar the stock, and when the chuck-jaws are opened it advances the rod to an easy contact with the stock-



stop, which is attached to the head-stock. Each tool in the turret has a separate stop, carried in a bracket on the front of the bed, against which an arm traveling with the turret-slide, always comes to rest when the tool is moved forward. These stops are easy to adjust.

The double cross-slide is fitted with two tool-posts of special design and both the cross-slide and the turret-slide have four changes of positive power-feed in each direction. The handles for changing the feeds are conveniently located on the front of the head-stock. The double cross-slide has adjustment along the bed by screw and hand-wheel.

The turret tools are bolted to the broad faces of the heavy turret which supports them directly in the line of strain. In the illustration the machine is shown equipped with universal turners and end forming tool.

The tools usually furnished are: one or more universal turners, multiple turner, end forming and pointing tool, bell-mouth pointing

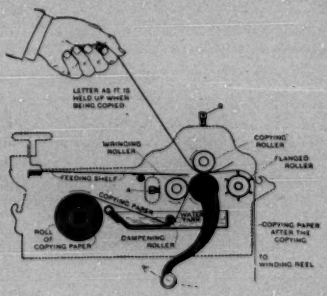
tool, taper turner. The spindle has double friction back gears which with three-speed countershaft gives 27 spindle speeds.

The Niles-Bement-Pond Company, 136 Liberty Street, New York, may be addressed for further information.

THE RAPID ROLLER LETTER COPIER produces without delay copies of pen and ink, indelible pencil or typewritten matter, showing in the copy the exact signature and all changes made in the original letter.

Two japanned cast-iron sides, connected by stay rods, support the feeding shelf, roll of copying paper, water pan and rollers.

As shown in accompanying illustration, the roll of tissue copying-paper, containing sufficient for 1,000 copies, passes into a removable brass nickel-plated water pan, beneath the dampening roller, then up



between the wringing and hard roller, where all superfluous moisture is removed. The wringing roller is adjusted by capstan-headed screws, with lock nuts, the adjustment being permanent.

From the wringing roller, the paper passes between the hard roller and compression roller, where the letter to be copied is inserted between the moist copy-paper and the compression roller. The latter is adjusted by means of capstan-headed screws with lock nuts, and is brought into action by means of a bar cam-lever acting on both end bearings simultaneously. After adjustment has once been made uniform pressure is always obtained by the lever, and with consequent uniform results.

The paper with the impression passes out over the radial flange roller, then down into the base, where it is drawn just sufficiently taut to dry smoothly, and is wound automatically on a metal reel.

The open base allows a free circulation of air and dries the paper quickly. When dry, the copies are removed by breaking the roll of paper just above the reel and releasing the small thumb-nut which engages the driving pulley attached to the shaft of the hard-rubber roller. This permits the reel to be reversed, and the copies drawn off are passed between the cutter-blades at the back of the machine, where they are separated, ready to be filled with the original letter. The cutter-blades are kept in contact by means of a spring pin adjustment, and being bevel ground are self-sharpening.

The hard-rubber, or main, roller is driven by a 3-to-1 internal gear, meshing into a pinion keyed to the crank shaft. This reducing gear allows the machine to be operated with the least possible effort, and permits the use of a shorter crank. It also reduces the copying speed, making it impossible to run copies through too quickly. The copier can also be driven successfully by a small motor.

All parts are interchangeable and easy of access. Bright parts are nickeled on copper. The rubber rollers are specially constructed, and run in phosphor-bronze bearings. The dampening roller is of brass nickel-plated, bulged at the center, tapering toward the ends. This removes all wrinkles and puts the greatest strain on the center of the paper.

The "Rapid Roller-Copier" avoids the use of wet cloths, blotters and oil boards. There are no annoying delays, as it is always ready for use. The pressure being uniform, the resulting copies are always as clear as the original. The original shows no signs of having been copied, and is always clear and presentable.

The machine has just been investigated by the Committee on Science and the Arts, and has received the award of the Edward Longstreth Medal of Merit. The machine is manufactured and sold by The Yawman & Erbe Manufacturing Company, Rochester and Philadelphia.

IT MAY INTEREST STEAM USERS to read the following description of an improved damper-regulator, manufactured by Wm. P. Dennis, 633 Arch Street, Philadelphia, for which specially meritorious features are claimed:

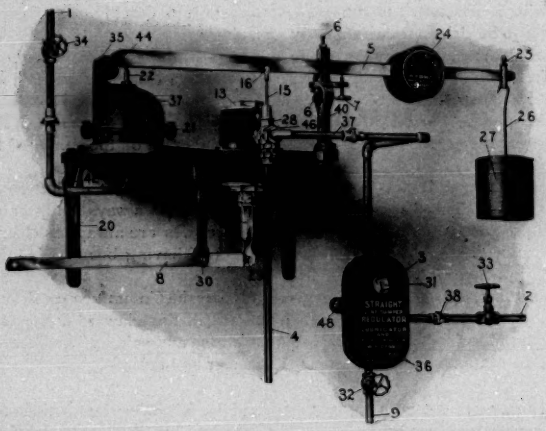
Referring to accompanying cut: (1) is a $\frac{3}{8}$-inch pipe leading from dome chamber which admits the pressure under the diaphragm. The connection to the boiler is made from any point where it is possible to get the direct steam pressure. On the top of the diaphragm is a pressure-cup and pin. The main lever rests with a knife-edge on the pressure-pin. The slightest changes of steam pressure cause the lever to rise or fall; the lever being counter-weighted to the desired pressure to be carried on the boilers.

The valve stem (15) is connected to the lever with a yoke and loose connection held in place by a $\frac{3}{16}$th hexagon nut. Any movement of the

lever causes the valve in the valve body to open or close the ports leading into the cylinder, giving the pressure either on top or bottom of the piston, which causes the piston-rod to travel up or down. This travel will throw the lever (8) in an upward or downward movement. At the extreme end of the damper lever (8) is attached the connection to the damper in the flues or stack.

The regulator is so accurately balanced that it will operate on $\frac{1}{20}$th of a pound change in steam pressure.

The sediment receiver and lubricator (3) is claimed to be a valuable attachment. If it is necessary to lubricate the regulator this can be done by removing the brass plug (31); (32) is the blow-off valve to remove any sediment coming into the sediment receiver from intake pipe (2).



The lock wheel (7) also is claimed to be a valuable acquisition to the regulator. By its means the damper can be entirely shut off and securely locked, thus preventing any possible chance of the damper becoming open, drawing up the fire and raising the steam during the night; also, the lever can be so adjusted as to have the damper open at any desired point (say one-quarter) to carry off the gases. If steam should possibly come up during the night, as soon as the pressure for which the damper is set is reached it would close the damper tight. The regulator will operate from any point of the stroke, ¼, ½ or ¾, or any fraction of the stroke. The apparatus is not a wide open and shut regulator.

Further information may be obtained by addressing the manufacturer, William P. Dennis, 633 Arch Street, Philadelphia, Pa.